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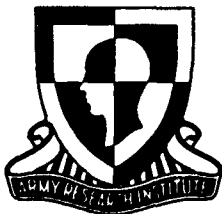
Technical Report 979

A Description and Evaluation of Selection and Classification Models

Janice H. Laurence and R. Gene Hoffman
Human Resources Research Organization

June 1993

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13. ABSTRACT (Maximum 200 words) This report is part of an overall project to identify and evaluate alternative models for selecting and classifying soldiers into military occupational specialties. Tasks 1 and 2 of the project are documented in this report. More specifically, this document contains descriptions of the selection and job assignment processes in the Army, Navy, Marine Corps, and Air Force in terms of their intended design and operational reality. Subsequent to the description of current military selection and classification systems, alternative models are presented and evaluated along numerous qualitative dimensions.				
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FOREWORD

The U.S. Army has embarked on a line of research to evaluate and improve its existing selection and classification system. Toward this goal, the Selection and Classification Technical Area (SCTA) of the Manpower and Personnel Research Division (MPRD) at the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) contracted with the Human Resources Research Organization to identify and evaluate alternative selection and classification models.

This effort was part of a project entitled "Identification and Evaluation of Selection and Classification Models for Military Operational Specialties (MOS)," conducted by researchers under contract to SCTA during FY 1992 and FY 1993. The report describes the selection and classification processes in each of the four military services and qualitatively evaluates subsequently identified models. Later reports in connection with this project will document the criteria against which the costs and benefits to the Army of each model can be measured and evaluated. The final report will summarize and integrate the results of this effort.



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ACKNOWLEDGMENTS

The authors would like to recognize the contributions of numerous colleagues who contributed to this report. The Contracting Officer's Representative for this effort was Peter Legree of the U.S. Army Research Institute for the Behavioral and Social Sciences. Dick Harris, Manager of Human Resources Research Organization's Training and Performance Analysis Program served as the project director. Besides these individuals, the authors would like to thank Peter McWhite, Theresa Russell, Paul Hogan, Rod McCloy, James McBride, Jeff Barnes, and Brian Waters for assisting in the collection of the information that served as the basis for this report. Further, we are most indebted to the numerous Service representatives who took their time to answer our questions about selection and classification within their respective Services.

A DESCRIPTION AND EVALUATION OF SELECTION AND CLASSIFICATION MODELS

EXECUTIVE SUMMARY

Requirement:

The Army strives toward efficient personnel selection and classification methods. Although considerable progress has been made over the years, the Army wishes to enhance its selection and classification process in light of experiences of the other Services and the results of its large scale selection and classification validation project known as Project A. This report provides preliminary information toward this goal by documenting Army, Navy, Marine Corps, and Air Force selection and classification systems--including system components, goals, and the timing of specific job assignment decisions. Subsequently, alternative models are delineated and qualitatively evaluated for further consideration.

Procedure:

Information on current selection and classification models was culled from available written documentation as well as semistructured interviews with key personnel from each Service. Subsequent to providing descriptions of the Service models and procedures, alternative models, which incorporate aspects of the other Services' approaches (e.g., the use of job sets) and/or incorporate additional predictors, are qualitatively evaluated. The evaluation factors include the model's potential effects on recruiting, transitioning into the Army, initial training, subsequent job performance, and affective work orientation.

Findings:

Aside from the concepts of job sets and optimization, the other Services offer little in the way of model alternatives that the Army itself has not considered. By varying consideration of a single stage or two-stage classification process, as well as the introduction of spatial/psychomotor (SPM) tests, use of the Assessment of Background and Life Experiences (ABLE) temperament inventory for selection, and the timing of test administration, numerous model variants were identified. On the basis of evaluation factors,

10 alternative models were ultimately recommended for consideration. In addition to the current single stage model, the variations included substitution of job cluster or job set assignment before accession with MOS specific assignments relegated to the post-accession period. Further, the addition of SPM for either pre- or post-accession use is viable. The use of ABLE as a potential pre-MEPS should also be formally evaluated. Variants to these models in the form of substituting a formal pre-military entrance processing station (MEPS) ASVAB administration with a specific AFQT cut score used to weed out applicants from further MEPS testing are also worth considering. Preliminary evaluations of these models for making selection and either batch or sequential classification decisions were similar, with each option showing an array of desired effects. However, the relative strength of the effects awaits the results of modeling or more quantitative procedures, which are planned for subsequent phases of this project.

Utilization of Findings:

The information collected in connection with this phase of the research effort was used to formulate alternative selection and classification models for consideration by the Army, as well as to delineate goals of such models. The preliminary qualitative evaluation reduced the multitude of possible alternatives to a viable set that will comprise the initial set of models to be more formally evaluated in later stages of this project.

A DESCRIPTION AND EVALUATION OF SELECTION AND CLASSIFICATION MODELS

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A DESCRIPTION AND EVALUATION OF SELECTION AND CLASSIFICATION MODELS

BACKGROUND

Selection and classification for the military services is a large scale operation. Even though recent defense cutbacks have reduced the level of incoming personnel, the numbers are still impressive. Service recruiters begin the process by speaking to hundreds of thousands of prospects each year. From the multitude of prospects, some become "applicants," which is a term reserved for those who actually take the Armed Services Vocational Aptitude Battery (ASVAB). This battery of cognitive tests is used as the prime tool for making selection and classification decisions. In FY 1991, the first full year of the drawdown of forces, together, the Army, Navy, Marine Corps, and Air Force administered the ASVAB to approximately 378,000 youth.¹ The Army alone gave the ASVAB to over 130,000 young men and women. In this same year, the four Services enlisted approximately 206,000 non-prior service accessions. As the largest Service, the Army's share was 38 percent or about 78,000 new enlisted recruits. These newcomers to the military joined the 1.7 million active duty enlisted personnel (629,000 of which were in the Army's enlisted ranks alone). By the end of FY 1995, as the drawdown nears completion, there will be fewer men and women in uniform. However, with the Army's expected 472,000 active duty enlistees contributing to the Department of Defense's (DoD) overall enlisted active duty strength of 1.3 million or so, selection and classification efficiency and effectiveness remains a pervasive issue for the Services and particularly the Army.

Not only must the Army select a sizeable number of new recruits each year. It must assign incoming personnel to hundreds of entry level jobs or military occupational specialties (MOS) (about 275 at present). Furthermore, selection and classification is a continual--day in, day out--process as opposed to a "one-shot" deal. Real world contingencies preclude the Services from making selection and classification decisions in batch. Prospects do not line up at one door on one day to vie for one open job. Instead recruiters and classifiers in numerous and diverse sites around the country attract and evaluate prospective recruits for service entry and assignment to a training school and ultimately to an MOS in need of filling.

Needless to say the costs, both monetary and nonmonetary (e.g., lost opportunities), of selection and classification are considerable. Thus, the Army strives to make this endeavor both efficient and effective. Over the years, considerable progress has been made in the realm of selection and classification. No longer is one judged for entry solely by physical fitness as was the case in this nation's early militias and armies (Eitelberg, 1988). The process has even evolved from the 1940 cognitive standard of requiring only that recruits understand simple orders given in the English language (Eitelberg, Laurence, & Waters, 1984). Today, a paper and pencil cognitive aptitude battery is administered prior to service entry. In particular, the Armed Forces Qualification Test (AFQT), a combination of verbal and mathematics ASVAB subtests, serves as the main cognitive selection screen. AFQT percentile scores are categorized into five main groups--Categories I through V--in order of decreasing ability levels. Category III, covering percentiles 31 through 64, is subdivided into IIIA (percentiles 50-64) and

¹This figure does not include ASVAB testing in high schools around the nation as part of the DoD student testing program. Also excluded from this figure are persons who were tested via the ASVAB in a previous year and completed medical, physical, or moral examinations in FY 1991. Roughly speaking, there are almost twice as many applicants as accessions within a given fiscal year.

IIIB (percentiles 31-49). AFQT minimum standards for selection can be set at any point above the 10th percentile (as directed by law) but typically fall at a category boundary. Actually, there are further quality restrictions. DoD oversight ensures that other Congressional quality constraints are met. For example, since the early 1980s, Congress has set a 20 percent ceiling on Category IV accessions and mandated that at least 65 percent of Army male non-prior service accessions be high school diploma graduates. Service recruiting conditions determine specific quality goals beyond Congressional minimums. The Services seek to enlist recruits who score within AFQT Categories I through IIIA and who are high school diploma graduates and adjust minimum requirements and recruiting goals according to supply and demand. With regard to education standards for enlistment, the various secondary school credentials today are grouped into three tiers on the basis of the likelihood of completing a term of enlistment. Tier 1 includes traditional diploma graduates, adult education diploma holders, and persons with some college regardless of high school credential. Tier 2 comprises other alternative secondary school level credentials such as General Educational Development (GED) high school equivalencies. Persons without any form of secondary school credentials, so-called nongraduates, constitute Tier 3. Given that most Tier 1 members are high school diploma graduates, these terms are often used synonymously in military selection discourses.

Selection is but one side to the coin. As the military's mission diversified and as footsoldiers were transformed into technicians, the task of sorting those selected into jobs became more pressing. While management information systems now keep track of job openings, there remain vestiges of the basic classification process of World War II. Then, the Army General Classification Test (AGCT), comprising vocabulary, arithmetic, and block counting subtests, was used to sort new arrivals. In addition, as was the case in World War I, civilian experience was taken into account in assigning jobs. However, relatively few recruits could be identified with directly usable skills because of the Army's high demand for combat positions (Camara & Laurence, 1987). Thus each branch clamored for its share of quality soldiers as indexed by higher scores on the AGCT composite² and attempts were made to set standards for the various branches.

Today, cognitive tests continue to be used to assign entering recruits to jobs with different aptitude minimums and assignment priorities. The specific measures have changed as have the population characteristics. Prior experience and special skills may be considered in the assignment process. With the average age of today's accessions being only 19, however, such experience is generally absent. Therefore, the ASVAB is used to sort recruits into MOS.

The ASVAB contains more tests than the AGCT and was designed to assess more specific vocational aptitudes such as success in electronics training, mechanics, and the like. Rather than using one single general cognitive measure, job assignment makes use of various ASVAB subtest composites in addition to the AFQT. Recruits must meet the minimums on designated composites for job assignment. Different job clusters employ different composites and minimum cut scores vary within and across clusters. Aside from

²Five aptitude classification groups were derived for the AGCT, with classes I through V denoting decreasing general ability.

the use of more tests, a fundamental difference is that classification generally occurs earlier today than it did 50 or even 20 years ago. Current enlistment contracts specify the jobs for which new recruits will be trained. Such an early commitment is a departure from the batch cohort assignment following basic training that was standard around World War II and beyond.³ Army counselors now enter an applicant's test scores and other pertinent information into a computer. From the list of jobs for which the candidate is qualified and for which there is an upcoming training seat, he or she chooses an MOS.

The Army is looking to enhance its selection and classification process in light of certain key events. First and foremost, the Army is seeking to harvest the fruits of Project A--its large scale, seven-year selection and classification validation project that was completed in 1989 (see Shields & Hanser, 1990). Project A provided Army-wide and MOS-specific criterion measures as well as new predictors. Thus it is possible to relate the current ASVAB to training and job performance and to assess measures of temperament, interests, psychomotor skills, and spatial reasoning for improving job assignment decisions.

Not only would the Army like to evaluate the costs and benefits to be derived from using additional tests, it would also like to address the timing of assignment decisions on the selection and classification process. That is, the Army is interested in "what" should be used for selection and classification and "when" this information should be used.

Although selection and classification improvements are valuable at any time, currently the value is amplified due to the downsizing of the military (especially the Army). As MOS are consolidated and change rapidly, it is vital that the Army's selection and classification system efficiently recruit and assign applicants with requisite job skills.

This document contains descriptions of the selection and job assignment processes in the Army, Navy, Marine Corps, and Air Force in terms of their intended design and operational reality. This information was culled from available written documentation (including recently completed related reports--Hogan & Mullin, 1992 and Russell, Knapp, & Campbell, 1992) as well as semi-structured interviews with key personnel from each Service. Subsequent to the description of current military selection and classification systems, alternative models are presented and evaluated along numerous qualitative dimensions.

CURRENT SELECTION AND CLASSIFICATION BY SERVICE

Selection and classification are related but not synonymous processes. Selection involves simply a yes or no decision. The applicant is either accepted or not. Classification, on the other hand, involves placing those available into different jobs either subsequent to or in lieu of selection. Classification is the more complicated procedure and in many ways drives selection decisions. That is, selection cut scores are determined by supply

³The current practice of specific pre-enlistment assignment was instituted by the Army in response to recruiting conditions under an all-volunteer force. The lack of job guarantees is thought to dissuade volunteers while presenting no problem under conscription or times of compulsory service.

and demand plus past training and job performance outcomes for recruits. Classification concerns itself with multiple job (or job cluster) specific measures that are most relevant and valid for predicting performance. While all Services use the ASVAB for classification, each Service determines its own blend of subtests from which composites are formed for job assignment purposes. Table 1 presents the composites as they existed at the time of this report.

These composites are the primary cognitive determinants of initial job assignment. Generally speaking, different job families are "governed" by different composites and jobs within families may have different composite score minimum requirements for assignment. The Services have between 15 and 50 occupational fields that generally comprise between 20 to 50 functionally similar jobs each. For example, the Army's Career Management Fields (CMF) were operationally implemented in the early 1970s. Today there are 34 CMF with MOS grouped into categories such as Infantry, Combat Engineering, Aircraft Maintenance, Administration, and Transportation. The Navy has 85 separate ratings in 15 occupational groups. The Air Force has about 250 specialties grouped into 49 career fields and the Marine Corps has about 400 MOS which fall under 49 occupational fields. For their various jobs and occupational fields, the Services use different composites. The Army uses 10 composites, the Navy uses 11, and the Air Force and the Marine Corps each use 4.

Before describing details of each Service's selection and classification model, Figure 1 presents an overview of the factors used to make such initial decisions within each Service. As can be seen from the figure, the first two steps are very similar across Services. More deviation occurs in the latter two parts of the enlistment process.

First, recruiters conduct the initial screening of enlistment prospects. Such screening includes ascertaining the individual's citizenship status, education credential, moral character (i.e., drug use, criminal record), and overall physical condition. Recruiters also administer a shortened version of the AFQT to determine a candidate's likelihood of qualifying for service. The paper-and-pencil version of this pre-screen is called the Enlistment Screening Test (EST). The Army also has available a computerized version called the Computerized Adaptive Screening Test (CAST).

Subsequent to selection prescreening at the recruiter level, individuals who continue the process are transported to one of 67 Military Entrance Processing Stations (MEPS) or, more likely (i.e., in about 60 percent of cases), to one of 850 associated Mobile Examining Team (MET) Sites. At the MET site, which is located in a public building such as a post office, only the ASVAB is administered. Further processing, for those interested and still qualified, takes place at a MEPS. It is here that the ASVAB is administered to those who did not test at a MET site. For those previously tested, the ASVAB is officially scored at the MEPS. Applicants then go on to physical and medical screening. All Services use the PULHES system--an acronym for assessing Physical, Upper Extremities, Lower Extremities, Hearing, Eyesight, and Psychiatric conditions. HIV testing is conducted at the MEPS as well. In addition, the Air Force tests applicants for physical strength--the so-called X-factor.

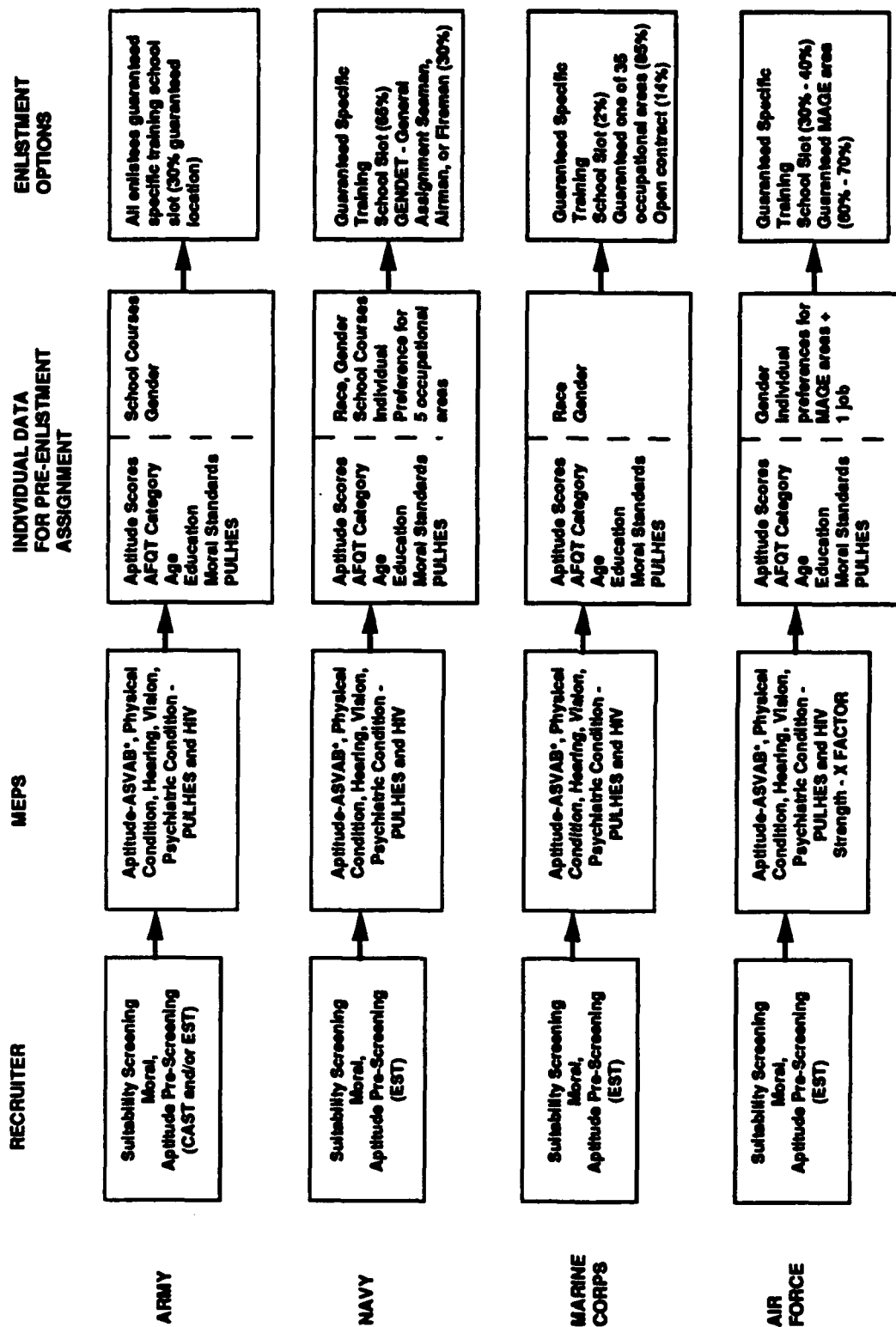
Table 1

Current ASVAB Composites Used for Assignment by Service

Army	Air Force	Marine Corps	Navy	ASVAB Subtests
General Technical (GT)	General (G)	---	General Technical (GT)	AR + VE
---	---	General Technical (GT)	---	AR + VE + MC
Electronics (EL)	Electronics (E)	Electronics Repair (EL)	Electronics (EL)	GS + AR + MK + EI
Clerical (CL)	---	---	---	VE + AR + MK
---	Administrative (A)	---	Clerical (CL)	NO + CS + VE
---	---	Clerical (CL)	Business and Clerical (BC)	MK + CS + VE
Motor Maintenance (MM)	---	---	---	NO + AS + MC + EI
---	---	---	Mechanical (ME)	AS + MC + VE
---	---	Motor Maintenance (MM)	---	AR + AS + MC + EI
---	Mechanical (M)	---	---	GS + 2AS + MC
Combat (CO)	---	---	---	AR + CS + AS + MC
Field Artillery (FA)	---	---	---	AR + CS + MK + MC
Operators/Foods (OF)	---	---	---	NO + AS + MC + VE
Surveillance/Communications (SC)	---	---	---	AR + AS + MC + VE
---	---	---	Basic Electricity/Electronics (E)	GS + AR + 2MK
Skilled Technical (ST)	---	---	---	GS + MK + MC + VE
---	---	---	Boilerman/Enginemen/Machinist Mate (EG)	AS + MK
General Maintenance (GM)	---	---	---	GS + AS + MK + EI
---	---	---	Machinery Repairman (MR)	AR + AS + MC
---	---	---	Submarine (ST)	AR + MC + VE
---	---	---	Communications Technician (CT)	AR + NO + CS + VE
---	---	---	Hospitalman (HM)	GS + MK + VE

Source: Bloxom (1992).

Note: VE consists of WK + PC subtest raw scores added together and then converted to a standard score.



* May be administered at a MET site.

Figure 1. The Military enlistment and assignment process

From information gathered in the first two steps, selection and classification decisions are made. Pertinent applicant data are processed and, following a determination of qualification for basic enlistment, individuals are matched with jobs or job areas. Service career counselors or classifiers at the MEPS discuss the available enlistment options, which appear on a computerized job reservation system, with the applicant and attempt to secure an enlistment contract. If the applicant is satisfied with the terms of the contract, he or she is sworn in and ships almost immediately or enters the Delayed Entry Program (DEP) with a specified entry date within 12 months (and usually within four months).⁴

The left side of box 3 in Figure 1 is the same for all Services. Though all four Services use the same information, specifically AFQT, aptitude composites, PULHES, and education credential, requirements may vary across Services. The right side of box 3 shows data elements used for classification that differ by Service. The Navy and Marine Corps actively incorporate race into their assignment algorithms so as to ensure that minorities have access to jobs in which they are underrepresented. All Services take gender into consideration when making job assignments because of legal and policy restrictions on women in combat positions. The Army considers high school courses for classification, and the Navy and Air Force incorporate individual preference to a greater extent than the other Services. The data presented in box 3 are used to sort applicants into specific job training slots or occupational areas prior to actual enlistment. The degree to which specific versus general assignment is used varies by Service. The Army assigns all of its incoming recruits to a training school at enlistment whereas the Marine Corps assigns few at this point in time. Although the Air Force makes more guaranteed specific training assignments at the point of enlistment than the Marine Corps, its occupational area assignments are more broad than the Marine Corps' (i.e., 1 of 4 occupational areas versus 1 of 35, respectively).

Next, more detail on the Service selection and classification models is provided. Some insight into how the data are used to meet selection and classification goals and constraints is given. A conceptual description only is provided, the mathematical underpinnings are beyond the scope of this report.

SERVICE MODELS

Army

The goal of selection for the Army is to enlist as many "quality" recruits as possible. Because of empirical relationships with term completion, training, and job performance, quality recruits are defined as high school diploma graduates or Tier 1 credential holders⁵ and those who score within the upper half of the AFQT distribution. Today, practically all recruits are high school diploma holders and Category IV accessions are restricted to about 2 percent. Also, current Army operational policy restricts Category IIIB new recruits to less than 35 percent of an entering

⁴Direct ship includes those placed in the DEP only to await the results of drug and HIV testing.

⁵The Army's goal of enlisting high school diploma holders is analagous to saying it prefers those in Tier 1.

cohort. Other criteria are considered in the selection process as Figure 1 above showed (e.g., citizenship, age, medical condition), but these are used primarily to determine basic eligibility or to screen people whereas cognitive aptitude criteria are more of a "selection in" tool. ASVAB standards are used to affect trainability. And, the emphasis on cognitive requirements indicates that trainability is the primary goal.

Classification goals include filling each MOS with recruits who pass the minimum MOS qualifications and providing each MOS with a requisite number and quality mix of recruits. Selection and classification activities must also ensure that each Recruiting Station Month (RSM) is met. That is, monthly quantity goals are set for each recruiting station to insure achieving the annual numerical goal. The Office of the Deputy Chief of Staff for Personnel (ODCSPER) determines the annual and monthly accession goals for the active Army and its MOS. With these in mind, the United States Army Recruiting Command (USAREC) sets monthly contract goals for its recruiting force broken down by AFQT category (I-III A; IIIB; IV), education credential tiers, gender, and prior-service/non-prior service missions.

To achieve these goals, recruiters initiate the process by prospecting and maintaining contact with potential recruits. Recruiters have numerical goals to meet as well as quality missions to satisfy. USAREC monitors the recruiting climate and determines the months when Category IIIBs and IVs may contract. To attract applicants, particularly quality applicants, conversations between recruiters and prospects focus on the needs and interests of the latter and how the Army can satisfy those needs. However, the content of the sales message is satisfying prospects' needs through general Army programs not a specific Army MOS. Although recruiters use the Joint Optical Information Network (JOIN) to present and explain general job categories and incentives, no promises regarding job training and assignment are made at the recruiter level.

Recruiters establish that the prospect meets the basic eligibility criteria of age and citizenship (i.e., ages 18-35 or 17 with parental consent; is a citizen of the U.S. or a citizen of U.S. territories, or a legal U.S. resident alien). Then recruiters assess general training, moral, and physical qualifications of the candidate; only after more formal aptitude testing and moral, physical, and medical evaluation does classification begin with the guidance counselor at the MEPS. The counselor makes written promises regarding MOS training and in some cases can offer choice of assignment location, participation in special programs (i.e., airborne or special forces), Army College Fund enrollment, bonuses, and college loan repayment plans.

With qualifications (including high school courses and Defense Language Aptitude Battery scores for those chosen to take the test on the basis of GT scores) established, counselors and applicants discuss a Service entry timeframe (or accession window), eligibility for bonuses and other incentives, and, if the applicant chooses, desired MOS. All of this information is assessed by the Army's job-person matching system called the REcruit QUota SysTem or REQUEST. REQUEST contains and considers current information on minimum qualifications and AFQT category goals (i.e., ratios of Category I-III A to IIIB-IV recruits required for specific occupations), MOS training class schedules, MOS training needs (Army priority and/or MOS criticality, remaining annual training requirements, remaining training space, and MOS

popularity as determined by the frequencies of class openings), and applicant availability. The recruiting process merges with the classification process when the applicant interacts with REQUEST. Selection goals transition to classification goals at this point.

The primary determinant of MOS assignment is meeting minimum ASVAB aptitude area composite scores (line scores). These are determined by the MOS proponent school at the Total Army Personnel Command (TAPC) and the Training and Doctrine Command (TRADOC), are approved by the Deputy Chief of Staff for Personnel (DCSPER), and are promulgated via REQUEST. Actually, MOS aptitude requirements rarely change. When they do, generally it is to tighten or ease requirements in response to a need for fewer or more people in an MOS. Standards are disseminated through the Qualifications File maintained on REQUEST's QUALS program. Standards for new or changed jobs are set by evaluating the similarities to like jobs (not necessarily within the same Career Management Field) with the number of people needed as a factor. REQUEST matches incoming recruits with MOS training slots for which they are qualified and tries to enlist the applicant close to the date of availability (the recruit's and the training school's).

REQUEST displays up to 25 MOS (plus the candidate's own choice) for which the applicant is qualified. The MOS are rank ordered and appear on the computer screen five at a time. Fewer than 25 MOS may be listed depending upon REQUEST's analysis of the Distribution of Quality (DQ) and its reanalysis/update of the delayed entry program (RUDEP) within and across MOS. The Army enforces target percentages of Category I-IIIAs within MOS and manages its DEP by determining for one or more MOS the accession month(s) available to a candidate within a given aptitude category and level of education. RUDEP considers such factors as whether the MOS class is seldom taught, the pace of MOS fill, and how hard it is to fill the MOS when determining whether to list the MOS and how far out in time to search (i.e., whether to go out beyond the target RSM).

The ordered list of MOS is strongly based on training class schedule and number of unfilled spaces. There is also special classification emphasis on MOS that are hard to fill because of stringent qualifications such as line scores at or above 110 (on a standard score scale with a mean of 100 and a standard deviation of 20), a line score at or above 100 plus a course requirement (e.g., high school trigonometry), or two line scores at or above 100. The REQUEST process that orders MOS, called Hierarchy, gives priority to filling school seats that might otherwise go unfilled. These priorities reflect not only value to the Army (e.g., priority 1 for 11X1 and 98XL) but also reflect the difficulty of filling the job. For example, 46R1, Broadcast Journalist, is a priority 1 MOS because candidates must provide a demonstration tape and few recruits can meet this requirement. Examples of varying priorities appear in Table 2.

Though qualified candidates can contract for any job on a REQUEST screen, guidance counselors are encouraged to "sell" an MOS from the first screen to better support the Army's needs. There are limited exceptions for highly qualified applicants (e.g., college graduates) wherein such persons may sign up for any open school seat for which they qualify. Counselors may use JOIN to provide applicants with specific information on jobs that are listed by REQUEST.

Table 2**Examples of Army MOS Prioritization Within REQUEST**

MOS	TITLE	PRIORITY
02D1	French Horn Player	6
11X1	Infantryman	1
13M1	Multiple Launch Rocket System Crewmember	1
13N1	Lance Crewmember	10
24M1	Vulcan System Mechanic	3
25R1	Visual Information/Audio Equipment Repairer	6
29V1	Strategic Microwave System Repairer	3
39C1	Target Acquisition/Surveillance Repairer	3
46Q1	Journalist	6
46R1	Broadcast Journalist	1
57F1	Mortuary Affairs Specialist	3
63T1	Bradley Vehicle System Mechanic	1
67R1	AH-64 Attack Helicopter Repairer	4
71D1	Legal Specialist	6
74D1	Informations Systems Operator	5
74F1	Software Analyst	6
77W1	Water Treatment Specialist	5
91A1	Medical Specialist	10
91G1	Behavioral Science Specialist	2
93P1	Aviation Operations Specialist	6
96F1	Psychological Operations Specialist	10
98XL	EW/SIGINT Specialist (Linguist)	1

As of January 1992.

In addition to REQUEST's Search mode, which lists MOS as described above, there is a look-up mode. Look-up is used to enter the applicant's one allowed MOS preference and to list applicable MOS for applicants who desire a specific time of enlistment. Look-up is often used as a last resort for applicants who have not found an acceptable MOS from Search.

Classification decisions in the Army are made on the basis of two weighted sets of factors:

- MOS Status - (weight 90 percent). This set includes factors for MOS priority, MOS fill, unfilled requirements, and class fill percentage.
- Applicant Qualification - (weight 10 percent). This set includes factors for aptitude qualification (test score category, education credential, aptitude area composite line score) and physical qualification.

Given the emphasis on MOS status, beyond meeting minimum MOS requirements, applicant qualifications virtually have no impact on REQUEST's ordered list of recommended jobs. For example, a Category IIIA applicant with a high motor maintenance (MM) composite score will see the same ordered list of MOS as a Category II applicant with a high Clerical (CL) and lower (but still qualifying) MM scores. In the current favorable recruiting climate, the flow of high quality applicants means there is no need to accept lower aptitude candidates even at the end of the recruiting month. Practically all candidates that meet selection requirements qualify for practically all available jobs as determined under the Army's current system. The heavy weight on MOS status suggests that optimizing MOS fill is judged more important than maximizing predicted performance through MOS classification based on applicant qualifications. All incoming Army recruits have a guaranteed training assignment at the time they sign an enlistment contract.

Navy

The Navy's selection goal, like the Army's, is to enlist high quality recruits. Currently, specific quality goals include accessing 95 percent high school diploma graduates (HSDGs) or Tier 1s and about 62 percent AFQT Category I-IIIIAs. At present, Navy recruiting policy prohibits the accession of Category IVs; only those applicants who score at the 31st percentile or higher on the AFQT are enlisted. Furthermore, the Navy tries to minimize attrition and "ensure" adequate training performance by targeting I-IIIIA HSDG (i.e., "A-Cell") applicants. The classification goals are to jointly maximize fill and quality. Appropriate classification is also seen as a means of raising the average AFQT of the career force.

Navy recruiters engage in "blueprinting." That is, they prescreen prospects with regard to moral (criminal and drug use questioning) and physical (visual check) criteria. Next, the Enlistment Screening Test (EST) is administered if there is no ASVAB score available from the DoD (High School) Student Testing Program. Recruiters also estimate applicants' likelihood of completing at least the first year of enlistment via the Success Chances for Recruits Entering the Navy (SCREEN) algorithm. On the basis of an applicant's predicted AFQT score range (estimated from the EST), education credential tier, and age, a recruiter can look up the SCREEN score that estimates the one year completion probability. The current minimum requirement is a score of 70, which precludes enlisting applicants with certain attribute combinations such as Tier 1 applicants who are 20 years old or older with AFQT scores below the 19th percentile. Tier 1 applicants with higher AFQT scores and who are below age 20 would meet the SCREEN minimum. Tier 2 applicants all must score 19 or higher on the AFQT and those in Tier 3

must be younger than age 20 and have at least a 38 on the AFQT. Given AFQT category and Tier 1 goals at present, hardly anyone is disqualified by SCREEN.

Beginning July 1, 1992 the Navy added a Compensatory Screening Model (CSM) to its selection tools to be applied to non-high school diploma graduates (i.e., those within education credential Tiers 2 and 3) who score within AFQT Categories I through IIIA. The CSM forecasts the probability of completing the first two years of service on the basis of years of school completed, education credential, age, AFQT category, employment status, military youth program participation, and moral waiver status. The Navy plans to allow up to 5 percent of accessions to be NHSDG I-IIIA's (or B-cells).

Navy recruiters show video cassettes, discuss the Navy in general and "sell" Navy travel and training options rather than describing specific Navy jobs, called ratings. However, experienced recruiters tend to know which ratings are hard to sell and may try to sell these ratings, although the Navy Recruiting Command actively discourages such behavior. The high school senior market is Navy's prime territory; but the Navy does not use their college fund as extensively as the Army; and therefore this market is more difficult for the Navy than the Army. Interested and promising prospects are sent to a MEPS or MET site, whichever is closer, for formal testing and evaluation. If the applicant meets the minimum aptitude, physical, moral character, SCREEN, and CSM requirements, classification ensues.

For persons who score within AFQT Categories I and II, classification begins with a pitch by the Nuclear Coordinator at the MEPS to try out for the nuclear field by taking the Nuclear Field Qualification Test (NFQT). Only about 5,000 "Nucs" are selected per year (around 5 percent of recruits) but such persons are a very select group and thus can be difficult to procure. The majority (about 65 percent) of recruits are scheduled for training at an A-school and the remaining 30 percent are classified as general detail (GENDET) seaman, fireman, or airman assignments following basic training.

The Navy's accession reservation system is called Personalized Reservation for Immediate and Delayed Enlistment (PRIDE). PRIDE contains a classification procedure (CLASP, for classification within PRIDE) that considers the needs of both the Navy and the applicant (Kroeker, 1989). The applicant may indicate up to five occupational group preferences, which then act as constraints for the CLASP algorithm. The Navy's 15 occupational groups have varying numbers of jobs associated with them, ranging from 2 to 14. The CLASP system evaluates applicants both on how they compare to the expected distribution of composite scores for future applicants and whether or not they meet a rating's ASVAB composite minimum (as does the Army system). Expected distributions are determined from the past year's distribution. Minimum ASVAB composite qualifications for the ratings are set by proponent agencies together with the A-schools. In addition, the Navy Personnel (NAVPERS) DoD Coordination Branch provides advice to the proponent agencies. That advice may incorporate information from validation studies undertaken by the Navy Personnel Research and Development Center (NPRDC). The Navy increases ASVAB subtest score requirements as necessary to reduce A-school attrition. In contrast to the Army, the cut scores for many ratings are sufficiently high that there are applicants who do not meet the requirements. Thus, classification decisions based on aptitudes are required even in a good recruiting market when the available quality is high.

The CLASP system uses six functions to estimate a payoff for each rating. The functions are as follows:

- 1) School Success Probability - This function is based on the relationship between ASVAB subtest scores and training school success. Success is estimated from regression equations for each job.
- 2) Aptitude vs. Job Complexity - This function involves comparing an applicant's technical aptitude (i.e., selected ASVAB subtest scores) and the job complexity of each rating.
- 3) Job Priority vs. Applicant Preference - Applicants' order of preference of 5 out of 15 occupational groups is contrasted with Navy priorities. The priorities are based on rating popularity, size, recruiting goals, and initial skill training school priorities. Ratings with high priorities weight individual preferences less than ratings with low priorities.
- 4) Minority Fill Rate vs. Minority Goal - The difference between the actual proportion of racial minority groups and the desired minority fill-rate for each rating at a given point in time is compared. Additional points toward fulfilling this goal are given to ratings if the minority fill-rate is lower than desired, whereas points can be subtracted in the opposite case.
- 5) Class Fill Rate vs. Class Goal - The difference between the proportion of applicants assigned to a rating and the average proportion of applicants assigned to all ratings at a given point in time is computed. Ratings with significantly more openings are then provided with extra utility points to increase these assignments while points are removed when the proportion of applicants assigned to a rating exceeds the average.
- 6) Attrition Risk - An individual's SCREEN score is examined in light of the costs to the Navy for personnel loss for each rating.

Each of these functions is weighted and a separate Decision Index (DI) is computed for each possible job-person combination. DI values are ranked and rescaled to form an optimality index ranging from 100 to 0 points for each rating. Ratings for which an applicant is not qualified and for which there are no openings within the month under consideration are removed from the list. Counselors and applicants discuss rating selection based on this optimality from the list of ratings.

The first two functions of CLASP indicate that the Navy has the potential to engage in actual or effective differential classification to optimize performance. In the Navy's system a person can be too "smart" for a job. The remaining functions address Navy organizational and policy constraints. The weights on CLASP factors determine the degree of emphasis on optimizing performance and meeting organizational constraints. Currently the Navy's Recruiting and Retention Programs Division (PERS 21) gives functions 4 and 5 only small weight. However, the effect of CLASP classification algorithms is mitigated by the degree to which classifiers push CLASP priority recommendations and by the availability of A-school seats. Classifiers can

only sell seats that are open regardless of the optimality values in CLASP. Classifiers can override PRIDE's recommendations if a seat is (or can be made) available with approval from Commander, Navy Recruiting Command (CNRC). This practice is discouraged. Classifiers encourage applicants to accept the earliest possible school dates, which are currently loaded into CLASP only six months to one year in advance. Under Navy policies, CLASP randomly releases school seats to the 41 recruiting districts to control offerings of desirable seats. Otherwise "market-rich" districts would sell a disproportionate share of the more desirable seats. These districts have sufficient high-quality applicants so that they can meet their near-term accession mission and, at the same time, build up their DEP pool. Thus, potential optimality is constrained by policy, training seat availability, classifier recommendations, and restrictions on recruiting districts.

As indicated above, not all incoming sailors are given a specific training assignment at the point of enlistment. For those who: (a) do not qualify for an A-school, (b) are unsure about what specific training they want, or (c) do not like the A-school offerings that are available, GENDET contracts are offered. Today, about 30 percent of Navy contracts are GENDETs. GENDET contracts are offered in three broad areas, Seaman, Fireman, and Airman, which are indicative of the type of duties or type of ship to which the recruits will be assigned. A basic seaman for example might assist those involved in shipboard operations or administration; a basic fireman might assist those with engineering ratings; and a basic airman might serve aboard an aircraft carrier. After boot camp, GENDETs receive two weeks of apprenticeship training. After apprentice-ship training, up to 10 percent of GENDETs may be offered a second chance to attend an A-school, dependent upon recommendations of their recruit company commanders and apprenticeship training instructors. GENDETs fill out preference cards that are matched against A-school seat availability. This limited classification after basic training lets the Navy respond to training requirements that were not known when the school plan was loaded into PRIDE. The flexibility afforded by GENDET positions may be called upon even more as force downsizing increases the uncertainties of fleet requirements. Strength planners estimate that next year's percentage of A-school guarantees will drop to about 50 percent. Presumably, a lower proportion of A-school contracts will mean an increase in the proportion of GENDET contracts and a subsequent increase in the proportion of GENDET recruits that are offered an A-school slot.

For GENDETs who remain such, duties at their first ship/station generally involve providing unspecialized labor and promotion is limited to E-3. Because their advancement is less certain than for A-school recruits, the Navy monitors GENDET minority percentages. The GENDETs can ultimately receive a rating and be advanced to E-4 (and thus be eligible to reenlist) by:

- Seeking on-the-job training (OJT) and then passing the E-4 advancement examination for their OJT rating. They will either be advanced to the rating promptly or be put on a waiting list as a designated "striker" awaiting availability of a position.
- Receiving a fleet quota seat for an A-school. Such persons may or may not be advanced, but at least they will become a designated striker and attend A-School with a better chance of passing the E-4 exam with a sufficient score to be promoted.

Following specific A-school classification or a GENDET assignment, applicants either direct ship or enter the DEP. Generally about 40 percent of a fiscal year's contracts are in DEP at any one time (with this figure running as high as 71 percent in FY 1992). The Navy views direct ships as a way to compensate for training school attrition. In fact, the Navy expedites direct ships by giving post-enlistment drug screening urinalysis at Recruit Training Centers rather than prior to enlistment at the MEPS as do the other Services. Thus, a direct ship is ready within three days for the Navy, waiting only for the results of the HIV test.

Given the same kinds of constraints related to class fill and recruit preferences, the Navy GENDET system incorporates a greater degree of job classification than does the Army system. So long as job openings exist and class fill is not highly weighted, higher cut scores for jobs and CLASP optimization algorithms permit a better person-job match of persons immediately classified into the A-schools. Furthermore, deferring the job classification decision for GENDET recruits increases the Navy flexibility to appropriately classify its personnel. Finally, predicted performance and attrition are incorporated in the Navy's classification process to a greater degree than in the Army's process.

Marine Corps

Like the other Services, the goal of selection for the Marine Corps is to accept quality recruits. Given the Marine Corps' relatively small numerical accessions requirements (e.g., just over 29,000 non-prior service accessions in FY 1991), quality is stressed more than quantity. Toward this end, the recruiter uses discretion to assess each applicant's potential within the basic requirements of being a high school diploma graduate and scoring above Category IV on the AFQT. The Marine Corps relies on high school graduation to predict both training success and first-term attrition. Concerning classification, Marine Corps representatives from the Personnel Procurement Division and the Manpower Plans and Policies Division, Headquarters, U.S. Marine Corps expressed confidence that the AFQT and other ASVAB composite "cut" scores support classification. The goal is to fill open school seats and match the required qualifications.

The selection and classification process within the Marine Corps is very different from the other Services. The differences are less apparent for selection but quite noticeable for classification as the following discussion will show.

The overall emphasis is to recruit a good Marine. However, recruiters are directed not to enforce their own qualification standards. Apparently there is a tendency for some recruiters to compare a candidate to a private who has already been indoctrinated by initial training. To counter this tendency, recruiters are encouraged to select recruits on the basis of required qualities and let the Drill Instructors turn them into Marines.

Marine Corps recruiting is guided by the Systematic Recruiting Process. This process is programmed in the Automated Recruiting Management System (ARMS) which incorporates a check list of recruit selection and processing steps. Candidates are prescreened on the basis of the Enlistment Screening Test (EST) or a high school ASVAB for scores within the Category I-III range. The Marine Corps sells its image primarily to a high school senior market.

Only candidates who are high school seniors or beyond are recruited for the current recruiting year. The recruiter also conducts the first moral screening and verifies that the applicant understands and is outwardly capable of withstanding the rigors of basic training. It is interesting to note that the age requirement for enlistment in the Marine Corps is more stringent than for the other Services. The age range for the other Services is from 17 to 35, whereas for the Marine Corps the range is from 17 to 28. Recruiters send to the MEPS only applicants who have made an implicit agreement to enlist. Bonuses are not readily forthcoming and are awarded only for special circumstances.

Though the Marine Corps recruiters emphasize "being a Marine first" and do not push training as an enlistment incentive, some broad-based classification begins at the recruiter level. A key feature to ARMS are "packages" usually associated with an occupational field that guarantee a training slot in a given month within a group of 10-15 MOS. Packages are developed by Marine Corps Deputy Chief of Staff for Manpower and allocated to districts, who in turn allocate them to recruiting stations. Packages can be traded between districts and overselling is permitted. Furthermore, slow selling packages are made available throughout a district and, if needed, nationwide.

Recruiters discuss interests with the prospective recruits, and expressed preferences become part of an applicant's selection of a package. Some recruiters start the first phase of specific job assignment by offering an unrestricted or open contract, which by its nature leaves preference out. Most (about 85 percent of Marine Corps contracts today) applicants are "sold" packages. The MOS contained within an option package are generally similar (e.g., combat, mechanical, aviation) but may have different aptitude requirements. Given the large number of MOS within some packages, a recruit's preference for a particular MOS has limited impact. However, applicants leave the recruiter for the MEPS presold on three packages, with an open contract as a backup. Discussion of open contracts and package options is solidified at the MEPS subsequent to formal ASVAB and other (e.g., physical) testing. The Marine Corps classifier at the MEPS may modify the recruiter's presold packages, but primarily the classifier's function is that of a quality control gatekeeper. Thus, recruits tend to accept the pre-offered contracts.

Classifiers guarantee specific training to a select few applicants (just under two percent) who are most desired by the Marine Corps. Recruits' eligibility for options and assignment to a specific MOS is determined by their scores on four aptitude composites. A recruit may qualify for an option by meeting the highest composite cut score in the package. Typically, all MOS within an occupational field have the same minimum requirements for aptitude scores, however, specific skills may be required for an MOS (e.g., swimming, language). MOS cutoff scores are determined by MOS proponent agencies. These minimums often cover groups of MOS and rarely change unless schools identify recruit failures with specific characteristics.

The very small number of MOS-specific assignments at the time of selection affords the Marine Corps greater flexibility down the road. The Marine Corps may over-recruit for a package (e.g., the popular aviation-related packages) because compensation occurs later with actual assignment to specific training seats when those seats become available. Specific classification for the Marine Corps is done in batch. Last minute duty

station and MOS assignment insulates the recruiting force from difficulties in long term forecasts of MOS requirements. Although ARMS checks recruit eligibility as a function of the package selected, classification to a particular MOS is accomplished via the Recruit Distribution Model (RDM). After recruit training all Marines have four weeks of Marine Combat Training (MCT). About once a month the appropriate region will run the RDM to determine first assignments for all recruits in MCT. Recruits with a package will be assigned to an MOS within that package whereas open contract recruits will usually be assigned to a combat MOS.

The Marine Corps image and primary role is combat thus combat MOS may get a higher priority than other MOS. Other priority jobs include presidential security and those using school seats from other Services. Recently the RDM was altered to allow incorporation of minority targets, but the minority target option is not in use. Generally, RDM priorities are situational, with weights in the model favoring MOS with open seats. That is, the algorithm uses a minimal cost solution to allocate recruits in batch to MOS on the basis of availability. The size of the batch is about 2,000 recruits. After meeting Marine Corps "fill" needs and satisfying any gender constraints and minority representation goals, the algorithm can make assignments to maximize the number of recruits assigned to jobs with the highest ASVAB cut scores and the average probability of training success. Job performance maximization is constrained because of the current recruiting climate, small numerical requirements of the Marine Corps, use of only four composites, and broad job categorizations. However, these factors together with the batch processing that takes place in the Marine Corps provides a flexible means for meeting manning requirements.

Air Force

Recruiting goals are set by the Air Training Command and the Directorate of Personnel Programs. The Air Force Recruiting Service translates these goals into reservation numbers that are set monthly by Recruiting Group with suggestions made by individual Recruiting Squadrons. Given positive perceptions of the Air Force, its relatively small size compared to the Army, and its job distribution, this Service succeeds in enlisting the highest quality recruits of any of the Services (see Department of Defense, 1990). These same factors contribute toward a classification system that attempts effective classification while maintaining management control.

De facto Air Force enlistment standards are considerably higher today than the official minimum standards. Whereas AFQT is the primary enlistment determinant in the other Services, operational cut scores on the Mechanical, Administrative, General, and Electronics (MAGE) composites are the main aptitude hurdles for the Air Force. That is, the minimum AFQT percentile requirements are 21, 50, and 65 for education credential tiers 1, 2, and 3 respectively. On the other hand regardless of educational attainment, operational composite minimums are at the 45th percentile on G with a combined percentile score of 185 on the MAGE composites. The effect of these ASVAB standards is that practically all Air Force accessions are high school diploma graduates and within AFQT Categories I-III A. Aside from strong reliance on ASVAB composites other than the AFQT, selection proceeds in the Air Force with a consideration of the same aptitude, moral, physical, educational, and citizenship criteria as used for the other services.

Classification considers applicant factors such as aptitude (AFQT category and MAGE scores), high school courses, physical profile (PULHES, vision, strength), gender, race, and interests as well as job factors such as difficulty and availability. The classification process begins at the MEPS following preliminary screening by the recruiter and further selection assessment including administration of special tests (e.g., Electronic Data Processing Test, Defense Language Aptitude Battery) by the MEPS liaison. At the MEPS, a counselor interviews the applicant, elicits job preferences for up to five Air Force Specialties, obtains ratings of preferences for the MAGE areas, ascertains an availability date, and enters the prospect's data into the PROcurement Management Information System (PROMIS). Through PROMIS, basic eligibility is determined and either a pre-enlistment training guarantee or a match to one of four broad job areas (i.e., Mechanical, Administrative, General, Electronics) is made. Currently, about 30 percent of recruits enter the Air Force under the Guaranteed Training Enlistment Program (GTEP). A specific job, or Air Force Specialty (AFS) is chosen from an ordered list of up to 16 AFSs with the first being the best choice in terms of both the payoff index and the Air Force's need to fill the job. The remaining 70 percent are open AI (aptitude index) contracts wherein only a M, A, G, or E promise is made. Open contracts are the norm now because the uncertainties of Air Force downsizing and restructuring make it difficult to project school seats.

The MEPS liaison manually checks the applicant's first job preference for job availability. If it is available and the applicant is qualified, a reservation and a GTEP contract is made. In today's recruiting environment all jobs are exhausted as soon as they become available. New jobs are entered into the global job bank twice daily and waiting recruiters process applicants as fast as possible. The job bank is maintained 12 months out with a phased release schedule within PROMIS. About 30 percent are released 12 months in advance, another 30 percent 8 months in advance; another 30 percent at the 5 month point and the remainder with only a 1 month lead. The Air Training Command makes partial releases by MAGE. The GTEP and open AI slots are updated monthly into PROMIS. Because not many specific jobs are available, a waiting list of qualified applicants is maintained.

The PROMIS payoff algorithm has five components that are weighted to allow a total of 1000 points. The components are as follows:

- Variable fill vs. aptitude/difficulty (600 points) - An individual's aptitude is matched to the difficulty of the job with Air Force needs or seat availability taken into consideration. If the job fill is being met, then the aptitude/ difficulty match is given a larger allocation of the 600 points. Conversely, if there is a need to fill the training seats, then the variable fill is given more of the points.
- Predicted Training School Success (50 points) - This is computed from equations that predict technical school grades from AFQT category, MAGE scores, and whether or not key high school courses were taken.
- Area Preference (180 points) - A value obtained from recruits' preference ratings for the MAGE areas.

- Minority/non-minority (70 points) - This component is not currently in operation, but could be used to assign points to ensure an equitable representation of minorities.
- Constant Fill (100 points) - Points added to every AFS for which a applicant is eligible.

Regardless of whether the recruit contracts under a GTEP or an Open AI, the final classification steps occur after enlistment. The 3507th Classification Squadron processes all new airmen during basic training at Lackland. For recruits with GTEP contracts, the 3507th verifies the GTEP classification to ensure accuracy and eligibility. Occasionally the guaranteed assignment cannot be kept because of lack of training opportunity or disqualification. In such cases, the recruit has an option to separate from the Air Force or accept another assignment. Counseling is provided in such cases and the Air Force reports that almost no losses result from broken contracts and the extension of other offers. Those with Open AI contracts receive formal job orientation and counseling in group and individual sessions throughout specific days during basic training as follows:

Day 4 - Career Assistance (group sessions)

Separate sessions by MAGE. Each group is briefed on the AFSs available and job description booklets are distributed. A biographical questionnaire, the History Opinion Inventory, is administered to screen for psychiatric and moral problems that would hinder certain job assignments.

Day 6 - Classification Interview (individual sessions)

- Personal data in records are verified
- Each recruit selects up to eight AFS preferences
- Interviewers elicit information relevant to the Personnel Reliability Program (as appropriate).
- Useful prior civilian employment, which can lead to direct assignment bypassing technical training, is identified.
- Special screening requirements are identified to avoid job-specific problems. For example, some recruits are tested for fear of heights, others are given flight physical exams.

Day 10 - Sensitive Skills Interview (selected airmen, individual sessions)

This interview probes into national defense issues for airmen who are eligible for and interested in assignments requiring Top Secret clearances. This is a disqualifying interview and disqualifying conditions are referred to an experienced adjudicator for resolution.

Day 12-14 - Computerized Classification Process

All airmen scheduled to complete basic training in a given week are classified by an automated batch process which takes into account:

- Air Force requirements and resources
- Individual qualifications and preferences
- Personal background and skill match

Assignment is done in group priority order with those promised a particular AFS processed first to ensure honoring this previous commitment. Within each group, individuals are processed one at a time, in no particular order. The group priorities are:

1. GTEPs
2. Those who will be hard to match because of low aptitude scores or physical disqualifying factors such as vision or hearing.
3. First-in/first-out--those scheduled for graduation on Monday are processed first; Friday last.
4. Volunteers for jobs identified as needing to be filled at the time.
5. "Must fill" - those not yet classified are matched by considering each job opening in priority order and seeking to fill each job with a qualified person who had that job on his/her preference list.

Day 28 - "Read-and-Weep" Day

This is the day on which individual notification of assignments is given along with a briefing of technical training school and the issuance of special orders as needed.

The computer algorithm that is used for post-enlistment classification is known as Processing and Classification of Enlistees (PACE) (see Pina, Emerson, & Leighton, 1988). The PACE system currently in use is a non-optimizing batch assignment system that sorts a weekly basic training cohort into available seats according to AFS preference, qualifications, and gender. A new PACE algorithm has been developed that includes the components of PROMIS plus takes into account training costs, lag time between basic training graduation and technical school entry, first-term attrition, and expanded measurement of occupational interests (based on the Air Force Vocational Interest Career Examination, or VOICE). This system has not been implemented in the Air Force, most likely because the current supply of quality recruits exceeds the job demand. Also, some at the Classification Squadron expressed concern that a new "optimizing" system might not assure a mix of recruit quality levels within jobs. This is the same issue that the Army resolves through its AFQT category goals for each job.

Toward an Evaluation of Alternatives

Which system is best for classification? The Army is considering alternatives that incorporate aspects of the other Services' approaches. Aside from considering optimization strategies, the Army might like to examine the effects of additional predictors and classification into job sets, which the other Services utilize to a substantial degree. It would appear at first glance that aside from the concepts of job sets (see Arabian & Schwartz, 1990) and optimization, the other Services offer little in the way of alternative procedures that the Army itself has not considered. The next section of the report provides a more thorough, albeit subjective, evaluation of alternative procedures for Army selection and classification.

EVALUATING SELECTION AND CLASSIFICATION PROCEDURES

Selection and classification procedures have a variety of effects, not the least of which is the resulting performance of the soldiers matriculated by those procedures. The procedures include a variety of cost-related factors that often conflict with each other and that affect recruits' decisions to join. Evaluating the tradeoffs inherent in alternative models requires specification of the procedures and identification of the important outcomes to be achieved. The identification of selection and classification outcomes can serve as system criteria for evaluating alternative procedures. These outcomes will be presented first. Discussion of alternative selection and classification procedures will follow.

Selection and Classification Outcomes

Table 3 presents a broad array of desirable outcomes assembled as criteria for judging the effectiveness of alternative selection and classification procedures. They fall into five different areas:

- recruiting
- transitioning into the Army
- initial training
- subsequent job performance
- affective work orientation

There appear to be two classes of performance criteria, those focused on aptitudes and those focused on performance. The difference however is largely a matter of the focus of attention. The Army's aptitude area composites originated from regression solutions predicting performance on MOS Skill Qualification Tests from ASVAB subtests (Maier & Grafton, 1981). Thus, there is an implied relationship between selecting recruits to meet a minimum level of aptitude and selecting recruits to increase performance.

In principle, the overall objective of the selection and classification system can be described as maximizing the value of the performance of recruits over the first term of service (and, perhaps, beyond) less the costs of generating that performance. Increased resources should be devoted to selection and classification up to the point at which the payoff, in terms of higher term performance and lower training costs, is no longer worth the additional recruiting, selection, and classification costs. In practice, we cannot place a dollar value on performance, so an alternative objective might be to minimize the costs of achieving a given level of performance. As a

practical matter, however, both statements of the objective suggest that the criteria for determining the "best" selection and classification system are the effects on: (1) performance; (2) attrition and training costs; (3) recruiting costs; and (4) the costs of the selection and classification system itself.

Table 3

Desirable System Outcomes for Selection and Classification Procedures

Recruiting	<ol style="list-style-type: none"> 1. Reduce cost of evaluating and testing recruits - the benefits of a test should outweigh its costs. 2. Reduce transportation costs - primarily associated with trips to MET sites and MEPS. 3. Satisfy recruit preferences - recruit has veto power of deciding not to join given the MOS offered. 4. Reduce recruiting costs - advertising and bonus costs associated with attracting high quality recruits.
Transition	<ol style="list-style-type: none"> 5. Reduce DEP loss - events after contract and prior to entry may lead recruits to withdraw or be dropped.
Training	<ol style="list-style-type: none"> 6. Reduce transportation costs - MOS assignments can reduce the distance between point of entry, basic training, and Advanced Individual Training (AIT). 7. Optimize training capacity - the cost efficiency of training is affected by the flow of recruits. 8. Reduce time between basic and AIT - the time between basic and AIT adds cost without benefitting the Army. 9. Increase probability of completing training - attrition and recycling represent wasted expenditures and opportunities lost to recruits denied positions taken by the failures. 10. Reduce training costs - inclusive of the above, plus potential acceleration of training from increased quality recruits.
Affective Work Orientation	<ol style="list-style-type: none"> 11. Reduce first term attrition - added to the concept of "performance." 12. Reduce number of discipline problems - added to the concept of "performance." 13. Increase motivational "will do" dimensions of performance
Performance	<ol style="list-style-type: none"> 14. Meet a minimum level of aptitude - use current AFQT cutoffs and MOS Aptitude Area (AA) requirements and/or develop new cutoffs for AFQT, AA, or new measures (e.g., ABLE, spatial/psychomotor tests). This criterion can be replaced by the number 15 below. 15. Match a distribution of aptitudes - there are AFQT distribution goals and MOS quality goals designed to insure assignment of a percentage of high scoring recruits to each MOS. Achieves two purposes: compensates for the lack of top-down batch selection and assignment to increase mean performance and provides a pool of soldiers for future leadership positions. 16. Increase average distance above MOS aptitude cutoff of those assigned; this will increase mean expected performance, but may not provide a select pool for future leadership positions. 17. Increase predicted performance - increase mean expected performance; differs from the above by focusing on a performance predicted by a combination of predictors rather than focusing on a predictor <i>per se</i>. Increasing overall predictive validity by adding independent predictors helps meet this criterion but does not help meet aptitude cutoff criterion. 18. Fill jobs with most qualified (highest quality) available - cannot be maximized at the job level because MOS must share recruits; can be a collective, Army-wide criterion. "Qualified" is by default defined by the selection/classification instruments used to predict performance. Adding valid predictors will help meet this criterion. 19. Fill all jobs with people who meet minimum qualifications - emphasis here is on meeting minimum needs of all jobs. 20. Meet fill priorities - adds a value concept (other than differences in ability requirements) to jobs; priorities may result from a static utility difference between jobs, or a transient quota difference. 21. Increase utility - similar to above with emphasis on static differences.

Alternative Models, Components, and Variations

The purpose of this work effort is to evaluate alternative procedures for selection and classification. Four alternatives have been suggested by the US Army Research Institute (ARI) in the Statement of Work for this contractual effort. Figure 2 shows the different measurement and decision components of these models. The first model represents the essence of the current system that the Army uses for most MOS. The alteration introduced in the second model is a two-stage assignment procedure, similar to those of the Air Force and Navy, in which a recruit is initially assigned to a cluster of MOS and later assigned to a specific MOS. This model is also used by the Army Infantry and Aviation MOS. It also allows using additional, but unspecified tests, to assist in making the specific MOS assignments.

The third model returns to the current single stage assignment procedure but adds two other features. The first feature is an explicit cut using AFQT scores prior to further testing. Because of the mission goals (AFQT category quotas) used by the recruiting command, there is already a certain amount of screening of low aptitude recruits. An explicit cut could reinforce that process. The second feature is the addition of the spatial/psychomotor test battery (SPM) developed in Project A. This battery has been shown to add to the predictive validity of the ASVAB aptitude areas tests for some jobs (McHenry, Hough, Toquam, Hanson, & Ashworth, 1990). It is also useful for classification decisions (Wise, McHenry, & Campbell, 1990).

The fourth model is a combination of the second and third models. It adds an initial AFQT cutoff, use of the SPM, and incorporates a two-stage MOS assignment procedure. The temperament/personality scales of the ABLE (Assessment of Background and Life Experiences) have also been shown to have validity. The scales predict the affective (or "will do") components of performance, including effort and leadership, personal discipline, and physical fitness/military bearing (Campbell, McHenry & Wise, 1990; McHenry, et al., 1990). Because these components are common to all jobs, the ABLE could be useful for selection decisions. It will be evaluated as an additional component to the alternative models.

The components specified by these models are summarized in Table 4. These alternatives provide the rudiments from which to begin constructing explicit models that can be formally evaluated. There are, however, a number of details that need to be added. A number of these are assumed to be constant across all of the alternatives. Others create options within the alternatives.

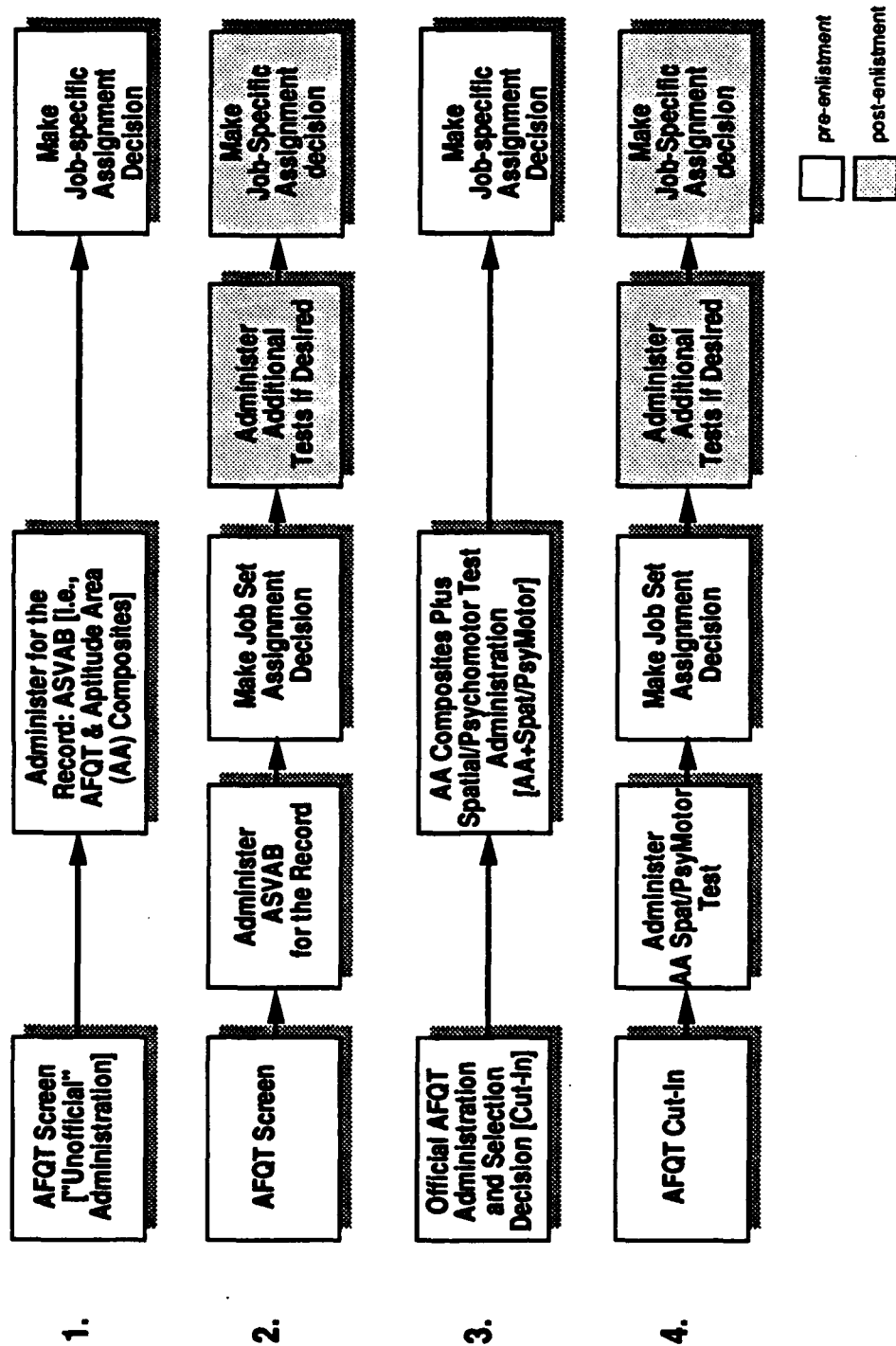


Figure 2. General selection and classification models

Table 4**Testing Options Represented in the Basic Models**

Pre-Screen	The CAST or EST is currently used by recruiters in an informal pre-screening of recruits. Low scoring recruits receive less encouragement to continue. The alternative is to institute a formal cutoff score.
Spatial/Psychomotor Test Battery	The spatial/psychomotor test battery may be added to increase classification efficiency.
Contract	Single-stage assignment results in recruits accepting contracts for specific MOS. Two-stage assignments result in recruits accepting contracts for a cluster of jobs with the specific MOS being identified at a later time.
ABLE (Assessment of Background and Life Experiences)	The ABLE may be added to the selection decision.

Constant components

Although not explicit in the models, there are features that are common to all models. These features are carryovers from the current system. First, selection and classification remain separate decisions for all models. AFQT scores are used to screen-out low scoring recruits and the ASVAB aptitude area composites are used for the assignment decisions. This means that if a recruit meets the AFQT requirement, there will be one or more MOS available for that recruit. Existing moral, physical, and educational screens are assumed to continue for all models and will occur in their present sequence. Although these procedures are used to screen out unacceptable recruits, they are nonetheless selection decisions. For our purposes, selection concerns those decisions made by the Army that preclude a recruit from contracting for any MOS. Classification decisions have to do with matching a "selected" recruit with an MOS. Second, the Delayed Entry Program (DEP) is assumed to continue in some form for all models. For administrative reasons, very few recruits proceed directly to the reception stations from MEPS. Thus, reducing DEP loss is an appropriate criterion for all models. Because of the tradeoffs among criteria and the potential for interactions, the common components can lead to differences in the overall effectiveness of the alternative models. Therefore, they must be considered in the evaluation process.

Timing of tests and decisions

The selection and classification process can be broken into three phases: events prior to MEPS, events at MEPS including the completion of contracts, and events following MEPS. The basic models imply a sequence, but are ambiguous regarding the phases in which the various components occur. For example, Models 2, 3, and 4 imply that the AFQT is to be given as a separate

test from the ASVAB. The AFQT is constructed from subtests of the ASVAB just like the other aptitude area composites. These models imply a two-step administration of the ASVAB: administration of only the subtests used to construct the AFQT score followed by a subsequent administration of the remaining subtests to recruits who make the AFQT cut. Alternatively, AFQT scores are obtained from either CAST or the full ASVAB, and the models may be interpreted as differing only in how the AFQT is used. Models 1 and 2 suggest that the AFQT scores are used by recruiters to make recommendations about continuing the application process. Models 3 and 4 suggest that there should be a set AFQT standard to be met before recruits can proceed to MEPS processing.

Models 3 and 4 imply that the SPM be administered prior to MOS or job set contracts being offered at the MEPS. In either case, SPM could be administered during MEPS or prior to MEPS (e.g., at a MET, Mobile Examining Team, site). Model 2 includes "additional tests" subsequent to a job set contract. This allows the possibility of using SPM to select specific MOSs within the job sets. In this case, SPM could be administered after MEPS but prior to AIT assignment. Testing recruits while they are in reception station processing is a practical alternative. Because the SPM requires specialized equipment, only the options of administering the SPM at MEPS or at reception stations will be further considered.

The timing of the ABLE is also ambiguous. To use ABLE as a selection test, it must be administered prior to completing contracts at the end of the MEPS phase. Options, then, include administering the ABLE prior to MEPS (e.g., at MET sites) or as an addition to MEPS evaluations.

Table 5 summarizes these options in combination with the testing options presented above. An additional assumption appears in the table: information from a test will be used at the time it becomes available. Thus, if the ABLE is administered prior to MEPS it would be used to screen-out potential discipline problems from proceeding to MEPS. Likewise, if the SPM is administered at the MEPS it would be used in negotiating MOS or job set contracts at the MEPS.

Combinations of options

The options identified in Table 5 were adopted as basic building blocks from which to construct more detailed selection and classification models. The 3 screening options combined with the 3 ABLE options lay the foundation for 9 variations. These 9 in combination with the 2 SPM options result in 18 different models for the options that include MOS contracts. For job set contract options, the 9 pre-screen-by-ABLE sets combined with 3 SPM options result in 27 more models. In total then, 45 different models were identified.

These 45 models are delineated and sorted into the categories defined by the basic models either, with and without ABLE. All but Model 1 are represented by several versions. Within the other basic models, versions differ on where ABLE is given, how AFQT subtests are administered and whether or not SPM is given as an "additional test" subsequent to a job set contract. Twenty-six of the versions do not match exactly any of the basic patterns. This is due to differences in pre-screen procedures. Because the CAST is highly correlated with AFQT and because recruiters do not encourage low scoring recruits to continue, versions that included a counseling pre-screen

function are much like those that include an explicit cut. Thus, uncategorized counseling pre-screen models that otherwise match features of AFQT cut models are grouped together. Likewise, adding a cut to counseling screen models is expected to change recruiting outcomes only if the cut is more stringent than current recruiting mission goals. Therefore, uncategorized AFQT cut models that otherwise match features of counseling screen models are grouped with those models. With these allowances in our categorization scheme, all 45 of the models are categorized as variants of one of the basic models. Table 6 presents the 45 models.

Table 5

Timing Options Implied in the Basic Models

Screening	Counseling screen with CAST or EST AFQT cut from administration of full ASVAB AFQT cut from administration of AFQT subtests only
ABLE	No ABLE ABLE administered and applied prior to MEPS ABLE administered and used during MEPS
Contract and Spatial/ Psychomotor Battery	<p><i>If MOS contract:</i></p> <ul style="list-style-type: none"> • No Spatial/Psychomotor Battery • Spatial/Psychomotor Battery at MEPS <p><i>If job set contract:</i></p> <ul style="list-style-type: none"> • No Spatial/Psychomotor Battery • Spatial/Psychomotor Battery at MEPS and used for job set assignment • Spatial/Psychomotor Battery at reception station and used for MOS assignment

Selection and Classification Algorithms

Even with the level of detail presented in Table 6, there are some additional considerations. In particular, specifications need to be made concerning procedures for making selection and classification decisions. These include: (a) use of sequential versus batch processing, and (b) use of cutoff scores or predicted performance estimates. These issues interact and are constrained by some administrative assumptions underlying the models. Thus, they deserve a rudimentary discussion. More technical details pertaining to military selection and classification are available elsewhere (Johnson & Zeidner, 1990).

Each model assumes separate selection and classification decisions. Therefore, the issues of sequential versus batch processing and using aptitude cutoff scores versus predicted performance need to be considered separately for selection and for classification.

Table 6

Alternative Versions of Basic Selection and Classification Models

Model	Pre-MEPS				MEPS			Post Accession	
	Initial ability screening			ABLE Screen Cut	Contract			Job Set Contract & Post Access Classifi- cation	SPM Classifi- cation
	Counsel- ing Screen	ASVAB with AFQT Cut	AFQT Cut with later subtest admin.		ABLE	SPM Classifi- cation	MOS Contract		
1. 1	X						X		
2. 1 w/cut		X					X		
3. 1 w/cut			X				X		
4. 2	X							X	
5. 2	X							X	X
6. 2 w/cut		X						X	
7. 2 w/cut		X						X	X
8. 2 w/cut			X					X	
9. 2 w/cut			X					X	X
10. 3		X				X	X		
11. 3			X			X	X		
12. 3 (Functional)	X					X	X		
13. 4		X				X		X	
14. 4			X			X		X	
15. 4 (Functional)	X					X		X	
16. 1+ABLE	X			X			X		
17. 1+ABLE	X				X		X		
18. 1+ABLE w/cut		X		X			X		
19. 1+ABLE w/cut		X			X		X		
20. 1+ABLE w/cut			X	X			X		
21. 1+ABLE w/cut			X		X		X		
22. 2+ABLE	X			X				X	X
23. 2+ABLE	X			X				X	
24. 2+ABLE	X				X			X	X
25. 2+ABLE	X				X			X	
26. 2+ABLE w/cut		X		X				X	X
27. 2+ABLE w/cut		X		X				X	
28. 2+ABLE w/cut		X			X			X	X
29. 2+ABLE w/cut		X			X			X	
30. 2+ABLE w/cut			X	X				X	X
31. 2+ABLE w/cut			X	X				X	
32. 2+ABLE w/cut			X		X			X	X
33. 2+ABLE w/cut			X		X			X	
34. 3+ABLE		X		X		X	X		
35. 3+ABLE		X			X	X	X		
36. 3+ABLE			X	X		X	X		
37. 3+ABLE			X		X	X	X		
38. 3+ABLE (Func.)	X			X		X	X		
39. 3+ABLE (Func.)	X				X	X	X		
40. 4+ABLE		X		X		X		X	
41. 4+ABLE		X			X	X		X	
42. 4+ABLE			X	X		X		X	
43. 4+ABLE			X		X	X		X	
44. 4+ABLE (Func.)	X			X		X		X	
45. 4+ABLE (Func.)	X				X	X		X	

Classification

Classification may be conducted by sequential or batch processing using either predictor cutoff scores or predicted performance scores. In general, batch assignment will yield more appropriate matches between job applicants and jobs. However, true batch assignment is possible only in the job set models and then it applies only to MOS assignments within job sets. Sequential treatment of recruits is necessary for models that use direct MOS contracts and for the job set assignment portion of job set models. However, it is possible to simulate a batch mode by predicting the number and quality of recruits entering the Army over the year. Then, for a given recruit, there would be an implicit "reservation demand" based on expected future arrivals. This "reservation demand" could be updated based on actual experience during the year.

Batch classification

Compared to sequential procedures, batch procedures can more fully capitalize on individual differences by making direct comparisons among the available applicants. We will consider three cases. All three cases are based on the ASVAB concept of having a variety of aptitude area composites available with the different MOS using different composites. The first case is a straw man in the sense that it is not currently being used and appears to have no strong advocates for its use. However, it is the most simple case and is instructive to consider. This case uses a single predictor for each MOS and evaluates recruits' scores in relation to cutoff requirements that are set for each MOS. The second case is a takeoff of the current system.⁶ Recruits may be assigned to an MOS if they (a) meet a set aptitude cutoff criteria on the relevant ASVAB area composite and (b) meet a "quality" category level, based on AFQT and education level. The quality category requirement is raised and lowered within each MOS to restrict the number of recruits in the lower categories. This is essentially a multiple hurdles approach with one of the hurdles frequently changing.⁷ The third batch classification approach is oriented on predicted performance. For every MOS, single or multiple predictors are combined (i.e., via multiple regression) to create equations that predict MOS performance. The equations can then be used to estimate predicted performance for each recruit in each job. MOS assignments are then made to maximize the overall level of predicted performance across all MOS. This is the maximum mean predicted performance (MPP) approach currently being advocated by Johnson and Zeidner (1990). Another, perhaps better way to explicitly incorporate performance is to select/classify so as to minimize the costs of achieving a given performance goal. As long as training costs and attrition rates differ for recruit quality categories for a given MOS, it will pay to take this into account in classification. Each of these will be discussed as it applies to the assignment of recruits to MOS within job sets given that an identified set of recruits is being evaluated (i.e., those who will begin training within a specified time period) and the job set assignments have already occurred.

⁶The current system is sequential rather than batch.

⁷We are simplifying somewhat by ignoring special assignment criteria, such as special vision requirements. These constitute independent hurdles that do not affect aptitude requirements.

Assignment based on MOS cutoffs on a single predictor. Consider the simple case for which there is one predictor per MOS (e.g., one of the aptitude area composites) and each MOS has its own cutoff score. A relatively simple batch procedure could be used to distribute recruits such that vacant training slots are filled with recruits that, in each case, are above the relevant cutoff. This is the least restrictive assignment procedure from the standpoint of aptitude requirements. On the other hand, this procedure may be the one that maximizes the opportunity to create assignment processes that incorporate non-performance criteria such as minimizing wait time and travel distance between basic combat training (BCT) and advanced individual training (AIT).

A somewhat more sophisticated assignment procedure could attempt to maximize the average distance above the cutoff across all MOS. Such a procedure is applicable only when MOS have different aptitude area composite requirements. If all MOS use the same predictor, then maximizing the average distance above the MOS cutoff would only insure that all assignments would have recruits above the cutoff for the MOS to which they were assigned. Given a linear model, all other assignment solutions will yield the same result.⁸ On the other hand, the means for the individual MOS can change. For this reason, it may be appropriate to alter the criterion to minimizing the variance of the MOS' means above their respective cutoffs. This adds a dimension of fairness among the MOS to the assignment. When there are different predictors for different MOS, appropriately assigning recruits to the MOS that best match their highest aptitudes can increase the overall average distance above the MOS cutoffs.

The way in which job sets are defined is critical in determining which system criteria the aptitude cutoff methods can achieve. If MOS within job sets are homogeneous with respect to aptitude requirements, then the practical classification decision occurs with the initial assignment to job set. Further consideration of the same predictors will be of little, if any, benefit other than insuring that any differences in cutoff requirements are met. For example, one candidate system for grouping MOS is the Army's Career Management Fields (CMF). The CMF groups are sets of MOS with similar missions and activities. MOS within a CMF tend to require the same aptitude area composite and cutoff level. This lack of differentiation among recruits, however, allows for the opportunity to meet non-performance assignment criteria.

If job sets are heterogenous with respect to aptitude requirements, then considering the different aptitudes for assignment to MOS within job sets is necessary and assignment procedures may attempt to maximize the average distance above the cutoff within the batch of recruits being processed. Achieving the requisite aptitude qualifications may diminish the capacity to incorporate non-performance criteria.

⁸Exchanging two recruits with different ability scores between two MOS that have different cutoffs will not change the sum of the distance between the recruits and the cutoffs: $(A-A') + (B-B') = (A-B') + (B-A')$, where A and B are recruits' scores and A' and B' are MOS cutoffs. Thus, across MOS, the average distance above the cutoffs will not change. However, if training costs and attrition rates vary between recruits A and B, it would make a difference which recruit is allocated to which skill even though mean predicted performance may be the same.

Thus, this basic assignment approach may be subdivided depending on whether or not MOS within a job set use the same or different aptitude area composites and for those that use the same composite whether or not they used the same cutoff score. If all MOS within a job set have the same aptitude area and cutoff requirement and given that recruits in the job set have been pre-classified, all assignment possibilities will be equal with regard to meeting MOS minimums and with respect to obtaining the highest average above the cutoff. If MOS within a job set have the same aptitude area composite, but different cutoff requirements, then assignments do need to be directed toward insuring that recruits meet the cutoff. Ignoring costs, there is nothing to be gained by attempting to maximize the distance above the cutoff, but minimizing variation among the MOS may be desired. If the MOS within a job set require different aptitude area composites, then assignment can attempt to meet MOS minimums or to maximize the distance above the cutoff.

Assignment to meet quality distribution goals. The aptitude cutoff procedures can be modified to assign recruits to match quality goal distributions. Interestingly, the current classification procedure adds consideration of quality categories that are defined by AFQT and education rather than creating layers of cutoffs for the aptitude area composites. Presumably, this is because the espoused purpose of the quality goals is to insure a pool of future leaders, and leadership is believed to be predicted more accurately by the comprehensive AFQT. This presumption seems reasonable in light of (a) the commonality of skills across MOS for leadership positions (Campbell, 1989) and (b) the appropriateness of general ability for predicting more cognitively complex tasks (Hunter, 1980). On the surface, this approach appears to assume that all recruits above the aptitude area composite cutoff are equal. On the other hand, AFQT correlates positively with all ASVAB composites so that distributing recruits by AFQT category will result in recruits being distributed by aptitude area scores as well. Furthermore, if MOS within the job set have different aptitude area requirements, assignments could attempt to maximize the distance above the composite cutoffs within the constraint of apportioning recruits by quality targets.

Thus, compared to the first method, recruits are still judged in relation to MOS cutoff scores. However, instead of one judgment per person per MOS, there are two: one based on the aptitude area composite for the MOS and one based on the quality categories. There is no provision in the model for a compensatory tradeoff between aptitude area composite scores and quality category. To be eligible for a particular quality slot within an MOS, a recruit must meet, or exceed, both the quality category criteria and the aptitude area cutoff.

Assignment to achieve maximum mean predicted performance. Recently, Johnson and Zeidner (1990) have advocated a classification approach that is traced to the works of Hubert Brogden and Paul Horst from the late 1950's through the early 1960's. The essence of the maximum mean predicted performance (MPP) approach is to calculate predicted performance scores for every recruit for every MOS and then fill training vacancies by allocating recruits to MOS in order to achieve the highest mean predicted performance across all of the MOS. Johnson and Zeidner review the assumptions and arguments that show that optimum classification efficiency (i.e., achieving the maximum mean predicted performance) occurs when multiple regression equations are used to predict performance, with selection and classification occurring at the same time. Although we do not question those assumptions and

arguments, we do think that there are some real-world constraints that should be considered--most notably, costs.

A potential concern that we will dismiss as a necessary system constraint is the previously mentioned stipulation that batch processing is limited to assignment of MOS after initial job set assignment has already occurred. In other words, MPP cannot be used to simultaneously select and classify because all of the recruits in the job set are expected to be classified to an MOS in the job set. The Air Force does renegotiate contracts when expected vacancies in one of the MAGE areas do not materialize. This practice, however, is not an intentional selection step because these recruits are placed in alternative positions. Thus, applying the MPP procedure to assignments within job sets is limited to classifying a particular number of recruits into a like (or nearly like) number of open positions. Applying the MPP approach to the within job set assignment problem can still give the maximum mean predicted performance for the given set of recruits.

To achieve maximum mean predicted performance, optimization algorithms are used. The logic of these algorithms may be described as follows. First, a recruit-by-MOS matrix of predicted performance scores is constructed, and each recruit is tentatively assigned to the MOS for which he/she has the highest predicted performance score. These assignments will undoubtedly not match the quotas needed for each MOS, with some MOS being assigned too many recruits and some being assigned too few recruits. In order to correct for this mismatch in numbers, the predicted performance score matrix is modified. For those MOS that have too few recruits, a constant is added to all of the recruits' predicted performance scores. For some recruits, the constants will change the rank order of their (adjusted) predicted performance scores. The assignment procedure then is repeated resulting in more recruits being assigned to the previously underrepresented MOS. The algorithms iteratively search for the set of constants which adjust the matrix so that MOS quotas are matched.

Figure 3 illustrates three hypothetical MOS constructed to illustrate the logic of the MPP approach. MOS A presents an MOS with a range of performance variability that allows a strong aptitude performance relationship to appear. MOS B conforms to an expectation about how the less difficult MOS might behave. In general, performance in MOS B is reasonably high for all levels of aptitude. As a result, the slope of the regression line for MOS B is much flatter than for MOS A. Note that although the regression line is flatter, performance in the two MOS may be equally predictable in the sense of MOS A and MOS B having equal standard errors of prediction. MOS C represents an MOS that is not well predicted by the set of aptitude measures. Predicted performance does not vary greatly across level of aptitude and the level of performance is centered.

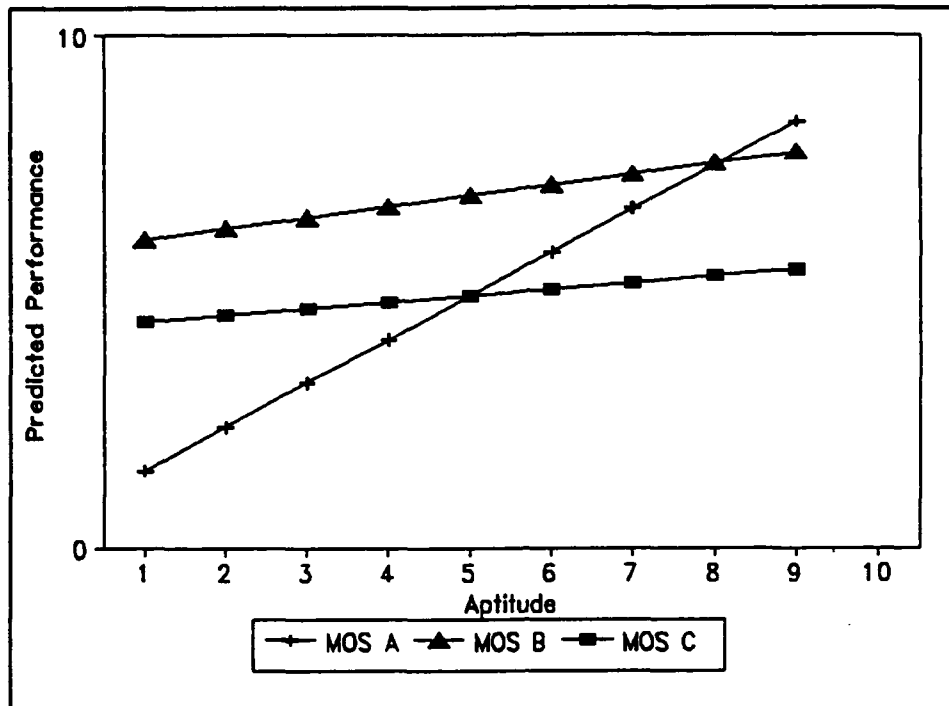


Figure 3. Aptitude/performance relationships for three hypothetical MOS.

In this simple case, the operation of the MPP approach is easy to see. If recruits were all assigned to the MOS for which they have the highest predicted performance score, then only the highest aptitude recruits would be assigned to MOS A, the rest to MOS B, and none to MOS C. Given that MOS C does have a fill requirement, a constant is added to MOS C which has the effect of raising the regression line for MOS C. Figure 4 illustrates this adjustment to MOS C. The highest aptitude recruits remain assigned to MOS A, but the rest are now split between MOS B and MOS C. MOS B, with the steeper regression line, is assigned the mid-range aptitude recruits, and MOS C is assigned the lower-range aptitude recruits. Similar adjustments up and down on any of the three regression lines may be needed to fine-tune the quotas.

Figure 4 also illustrates that the rank order of the slopes of the regression lines is very important in determining what level of recruits are assigned to each MOS. Because, in our example, MOS A has the steepest slope, MOS B the next steepest, and MOS C the flattest, no set of constants will change the order of recruit assignments. Other things being equal, the high aptitude recruits will tend to be assigned to the more predictable MOS and the low aptitude recruits will tend to be assigned to the less predictable MOS.⁹ From the "quality" definition in the quality goals perspective above, this could be interpreted to mean that the more predictable MOS are assigned the high quality recruits and less predictable MOS are assigned the low quality

⁹This tendency is reduced if multiple independent predictors are used and the MOS differ substantially in their aptitude requirements. However, the ASVAB aptitude composites are correlated and MOS have some similarity with respect to their aptitude requirements (Wise, McHenry, & Campbell, 1990).

recruits. From the MPP viewpoint, the quality goals perspective is an over interpretation of "quality." The multiple regression equations effectively exhaust all of the predictive power available in the aptitude tests indicating that the available predictors are less important for success in the less predictable MOS. However, even small differences are treated as "real." It is unlikely that a difference in slopes the size of our sample MOS B and MOS C would hold up as a statistically significant difference in any set of empirical data. Obviously, one should have a great deal of confidence in the differences in regression equations for the different MOS. There are a number of serious constraints surrounding the derivation of the predicted performance scores as it effects the appropriateness of comparing scores from one MOS to the next. The discussion that follows will examine the regression equation used to derive predicted performance scores.

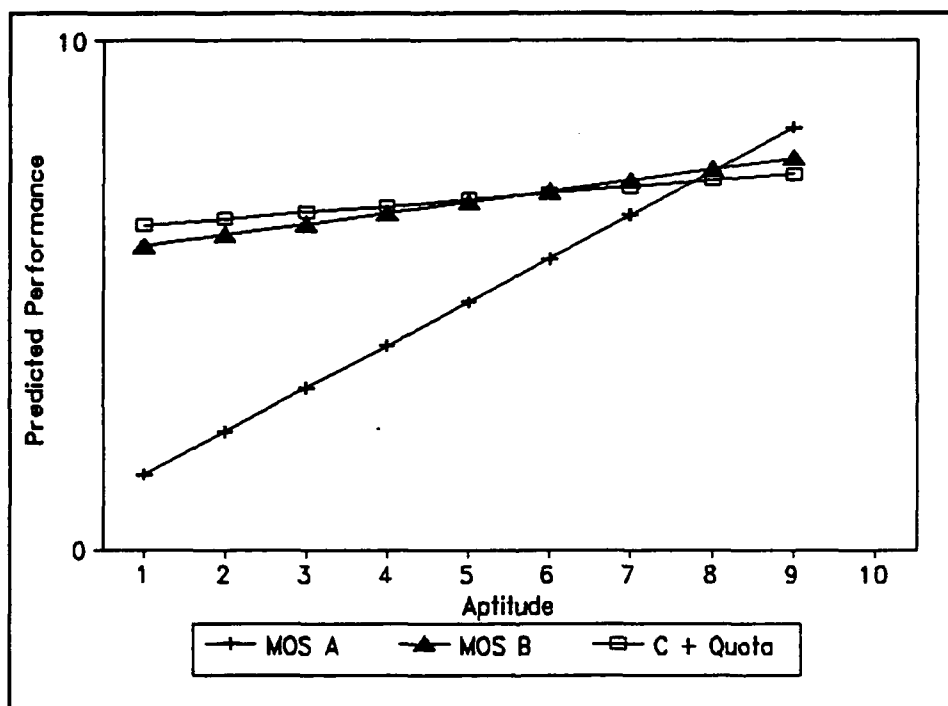


Figure 4. Effects of quota constant added to MOS C.

First, on the positive side, ordinary least-squares regression yields the optimum linear solution relating scores on one or more predictors of job performance.¹⁰ If there are no artificial limits on performance, there is no compelling reason to consider non-linear models for ability/performance relationships (Hoffman, 1989). Thus, the regression equation for each MOS effectively exhausts the information available from the predictor set about potential job performance in that MOS. The reason for selection and differential assignment is readily apparent--to provide soldiers who can

¹⁰ Ordinary least squares results in the best linear unbiased estimator when residuals follow certain assumptions such as being normally distributed.

perform. The cutoff and "quality" goals methods discussed above emphasize aptitudes almost to the point of equating them with performance. Clearly, the relationships are strong (McHenry, Hough, Toquam, Hanson, & Ashworth, 1990); however maintaining emphasis on performance facilitates the consideration of additional predictors and necessitates a more thorough consideration of the meaning of performance.

For a given set of recruit aptitude scores, MOS can differ in predicted performance scores for several reasons, all related to the components of the regression equations. These includes differences that affect the regression equation constant and differences that effect the regression equation weights. The weights, in turn, are affected by factors that influence either the standard errors of prediction or the standard deviations of the performance scores. An additional, related factor enters in also. Johnson and Zeidner (1990) indicate that predicted performance scores from different MOS may be differentially weighted to reflect differences in the value or utility of the MOS.

Scaling performance is undoubtedly the most vexing problem for deriving the regression equations that are to be used to make comparisons across MOS. The Joint-Service Job Performance Measurement/Enlisted Standards Project (JPM) emphasizes hands-on test performance on a sample of job tasks to infer the percent of the job that can be successfully performed (Wigdor & Green, 1991). This definition ignores any difference in the difficulty of tests as opposed to the tasks from different MOS. MOS currently differ in their aptitude cutoff scores, implying that MOS are considered to differ in task difficulty, which produces desirable variance in the dependent variable. To obtain performance score comparability, it is important to deal with variance due to: (a) job difficulty; (b) individual differences; (c) test difficulty; and (d) measurement error.

What are the implications of these conceptual differences in task difficulty? First, there is some ambiguity about what difficulty implies for the observed performance scores. Other things being equal, predicted performance scores should be lower for "difficult" compared to "easy" MOS. On the other hand, incumbents in the "more difficult" MOS have higher aptitudes and the training courses are longer. Thus, there is no clear indication whether observed performance should be higher, lower, or the same for MOS of supposedly different levels of difficulty. However difficulty is interpreted, if it manifests itself only as a difference in performance means as expressed by the regression constant, it may be eliminated by the quota constants added by the assignment algorithms to meet MOS fill requirements. Thus, MPP assignments to MOS of different difficulty will occur without any recognition of that difference. This confusion in scaling performance is one reason for making a multiplicative adjustment in predicted performance by incorporating a value or utility concept. In order for high aptitude recruits to be assigned to the difficult MOS, difficult MOS must have steeper slopes than easy MOS. This allows high aptitude recruits to be differentiated from low aptitude recruits such that there will be more to gain by assigning high aptitude recruits to the difficult MOS instead of easy MOS, and less to lose by assigning low aptitude recruits to the easy MOS.

Figure 5 illustrate the effects of weighting predicted performance value. In this example, predicted performance scores for MOS C were multiplied by 2, indicating an extreme value adjustment. The result, not

shown, was a line considerably above all of the other lines. Therefore, a constant was subtracted from the value-adjusted line in order to bring it down with the others and distribute recruits across all three MOS. The effect of the value adjustment is to make the MOS C line steeper. As a result, the rank order of the MOS assignments has been changed. MOS A is still assigned the top recruits, but MOS B and MOS C are reversed. The mid-range recruits are assigned to MOS C, and the lowest range recruits assigned to MOS B. Again, the figure emphasizes that the order of assignment may be determined by very small differences in the adjusted regression lines.

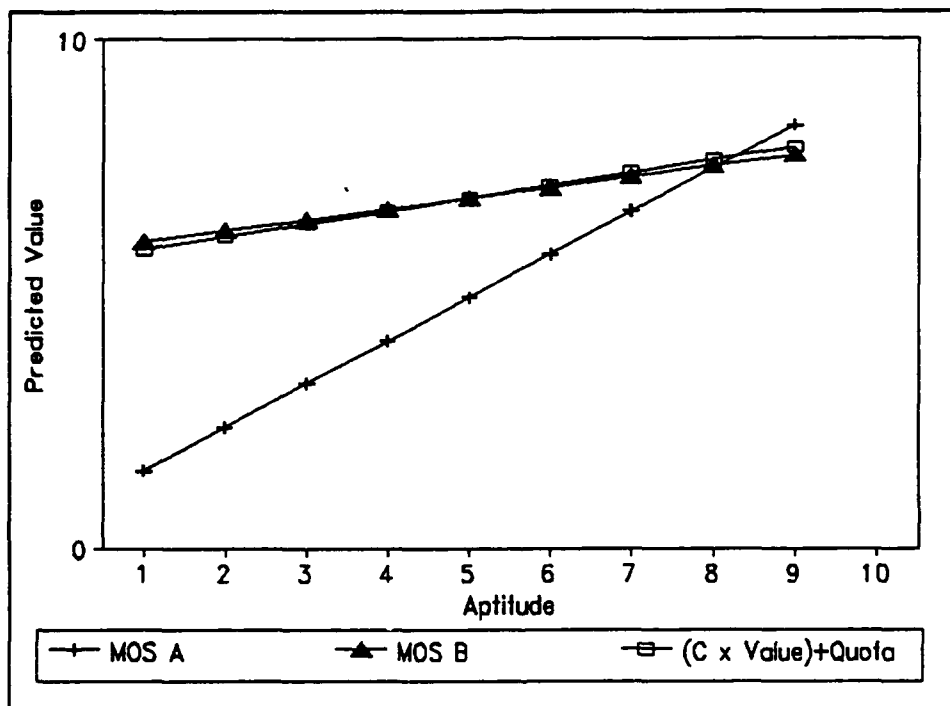


Figure 5. Value and quota adjustments for MOS C.

Other artifacts of performance may also distort predicted performance calculations. For example, although it was hard for Project A to quantitatively document, there was the impression that hands-on tests differed in reliability and in validity depending on the nature of the tasks being tested. That is, out of administrative necessity, some performance tests were more contrived than others.¹¹ These effects may all impact on the slopes of the regression lines.

In addition, the MOS differed in a subtle way that affected performance. For some MOS incumbents (e.g. motor vehicle operators and administrative specialists), performance of their MOS duties is much like the rest of the work-a-day world. They perform their important job tasks daily. For

¹¹These impressions are the opinion of the second author who was a job analyst, test developer, and data collection monitor for Project A.

incumbents in other MOS (e.g., the combat MOS), they can only practice their important MOS duties during intermittently scheduled training sessions. Indeed, the Project A tasks for which performance was less frequent tended to be performed more poorly.¹² Furthermore, the effects for experience were nonlinear. Thus, experience also confounds any attempts to interpret MOS difficulty from observed performance scores and the differences may affect both the regression constant and its slope.

The answer to this dilemma over the interpretation of performance scores is not to standardize performance and pretend that observed differences are not real. On the other hand, there is no obvious solution. The notion of making utility adjustments is appealing, but acquiring acceptable utility values is fraught with pitfalls (Sadacca, Campbell, DiFazio, Schultz, & White 1990). Harris et al., (1991) described a method to calibrate performance (criterion) scores across jobs. They used job-level composite scores to rescale the job performance scores. This procedure assumed that test difficulty has an additive effect on performance test scores and is uncorrelated with both individual and job characteristics. If these assumptions hold, the regression equations using the "rescaled" performance score will provide unbiased estimates of the effect of individual characteristics on job performance. They also showed that a multilevel regression model can provide unbiased estimates of the effect of individual characteristics on job performance.

Another, and related, difficulty with the MPP approach is that there is no explicit recognition of minimum aptitude requirements. This may not be a serious problem given that the MPP appears to be restricted to assignment of MOS within job sets for which recruits have been previously selected. However, if there is a divergence in cutoff scores, the MOS with the highest cutoffs will have to be value-adjusted to make them have the steepest regression slopes.

Finally, the concept of quality goals is lost with the MPP optimization approach. Explicit selection for future supervisory positions with separate regression equations is possible, but even then, because of the difference in time frame, the prediction of future supervisory performance is likely to have lower validity than the more immediate entry level performance. The result could yield the opposite of the intent with lower aptitude recruits allocated to the less predictable future supervisor slots. The lower validities argue that the aptitudes are less important for the supervisory jobs, but the result remains counter intuitive. A possible solution is to subdivide MOS by creating a separate category of positions for a cadre of potential leaders within the pool of basic recruits. Higher aptitude recruits will be assigned to the potential leader category if its regression line is given an appropriate value weight. Such tampering, however, certainly curtails the pristine empirical "objectivity" of the MPP regression-based approach.

The above discussion has focused on the case in which there is one predictor. MPP is not limited to one predictor. Indeed, to be most efficient, regression equations should include all available predictors (Johnson & Zeidner, 1990). Thus, relationships become more complicated than we have presented. However, the basic arguments are the same. Subtle

¹²Unpublished analysis performed by the second author.

differences in regression weights determine the level of the recruits assigned to the respective MOS. The MPP optimization method is much more mathematically sophisticated than our best data can support. Even then, empirical equations are available for only a small subset of MOS.

An MPP hybrid: Aptitude area composites revisited. An alternative to the strict MPP regression approach is to combine aptitude tests into a single score using unit weights for predictors above a minimum level of validity and zero weights for those below the minimum. Peterson, Owens-Kurtz, and Rosse (1991) show that this procedure captures most of the validity available from complete least squares solutions. On the other hand, unit weighting should remove the trivial differences between MOS. To yield comparable scores, sums resulting from each equation could then be divided by the number of predictors that are weighted in that equation. The result would be, in essence, an average (composite) aptitude score. Again, within each MOS such scores would be nearly equivalent to the regression equation scores because for correlated predictors the differential weights do not have much effect (Wainer, 1976). This procedure describes the development of the aptitude area composites (Maier & Grafton, 1981). They are the set of unit weighted equations that resulted from regressing performance in 19 different MOS on the ten ASVAB subtests. Thus, Johnson and Zeidner's (1990) emphasis on using the ASVAB subtests brings us right back to the ASVAB composites. Their arguments do, however, suggest using ASVAB composite scores in optimization algorithms that make assignments to maximize mean composite scores.

Sequential classification

Sequential processing treats one recruit at a time and is required for making initial contracts for either MOS or job sets. Similar to batch processing, cutoff and predicted performance procedures can be used to meet MOS requirements. However, recruits become players in the assignment process; they may turn down any MOS or job set that they are offered.

Aptitude cutoffs can be set and recruits offered any available (i.e., unfilled) MOS for which they are qualified. This procedure will guarantee minimum MOS requirements but may not meet the more stringent system criteria. Because recruits are processed in a nearly random order (i.e., as they come in), across time the recruit pool should have a relatively constant distribution of abilities and a stable system should result. However, MOS differ in popularity. During the time a popular MOS is open, recruits that are better qualified for less popular MOS may choose the more popular MOS. As a result, the more popular MOS are filled quickly and the availability of popular MOS is discontinued for a some period of time. It is during this time period that less popular MOS may regain some of their share of the high quality recruits. Therefore, MOS fill rates will vary unpredictably in the short run. Furthermore, the extent to which this balances out depends on the relationship between MOS popularity and MOS ability requirement. MOS that are unpopular and have high aptitude requirements may be difficult to fill. In an effort to add control, the current system frequently adjusts MOS availability to regulate fill rate and achieve equitable distribution of quality recruits. Obviously, the algorithms used to adjust MOS fill rates are an important addition to modeling classification offerings.

As an alternative, batch processing can be approximated in a sequential mode by using a hypothetical distribution of expected recruits and an estimate

of future MOS needs. Recruits can be treated sequentially by making MOS offerings that coincide with the assignments that they would be given if they were members of the hypothetical distribution. Estimates of recruits' abilities could be assessed as ASVAB aptitude area scores or predicted performance scores. If a recruit rejects an MOS offering, the comparison could be rerun with that MOS closed. Achieving the potential for this method to be effective requires accurate estimates of the distributions of future recruits for each MOS. If the estimated distributions overestimate the actual candidates, fill priorities may not be met as anticipated high quality candidates fail to materialize. If the expected distributions underestimate the actual candidates, aptitude levels may be lowered in popular jobs as positions are filled too quickly.

Selection

Although we have argued that selection and classification are separate processes, selection is a more ambiguous process than classification in the current Army system. There is no formal point at which recruits are accepted into the Army (i.e., guaranteed a slot) until the assignment process at the MEPS. On the other hand, the lowest aptitude recruits, if their scores are available, and recruits that do not pass the moral screen are not allowed to go to MEPS processing. Marginal recruits may be discouraged from going to the MEPS, depending on whether recruiters are meeting their missions for the month. Thus, selection currently is more a matter of screening out poor potential recruits than accepting clearly qualified recruits. Functionally, "true" selection occurs with MEPS assignment offerings. On the other hand, the screening process that occurs prior to the MEPS is an important cost-saving process. Again, administrative requirements for continuous processing dictate use of sequential processing for screening into the Army. Cutoff scores are necessary whether they focus on minimum aptitude or minimum predicted performance. Thus, the derivation of the cutoff scores is a significant variable in determining the effects of screening.

Commonality or lowest common denominator

Selection procedures must ignore the differences among MOS and treat the similarities. There are two options that correspond to placing emphasis on the aptitude measures versus placing emphasis on predicting potential performance. The current system emphasizes aptitude. It assumes that the general ability construct of the AFQT is valid for all MOS. Any differences among MOS in level of cognitive ability required are not addressed during screening. Theoretically, AFQT standards are set to meet the lowest MOS requirement. In practice, AFQT standards are a result of supply and demand. A second option is to focus on the elements of performance that are the same across MOS and create a prediction equation that extends beyond AFQT. Four of the five performance categories identified by Project A are consistent across MOS (Campbell, et al., 1990; McHenry, et al., 1990). These include the three affective performance dimensions mentioned earlier (effort and leadership, personal discipline, and physical fitness/military bearing) plus performance on the common skills that are applicable to all MOS. The common tasks and affective dimensions are relatively independent (Campbell, et al., 1990) with common task performance associated with ASVAB subtests and affective performance associated with ABLE subtests (McHenry, et al., 1990).

There is the danger of allowing the choice of what to predict to be driven by the choice of what predictors are used. That is, choosing to use the ABLE implies that the affective performance dimensions are important. Instead, the reasoning should be the other way around, first addressing the question of whether the affective "will do" dimensions are important to predict during the screening process. If they are, then the ABLE becomes an important tool. Any formal evaluation of the alternative screening models must begin with explicit definition of the performance domain. The Project A five-dimension domain provides a sound foundation.

Combining predictors

If performance is broadly defined to include the "will do" dimensions and the ABLE is added to the selection decision, the issue becomes how to combine the ABLE and AFQT. The alternatives are to combine them with a regression solution or to use them sequentially as multiple hurdles. The former focuses on predicted performance; the later on predictor cutoffs. In addition, the single equation will allow compensatory tradeoffs, whereas multiple hurdles will be non-compensatory. Given the independence of the ABLE and cognitive ability (McHenry, et al., 1990), the two methods can yield very different results. Furthermore, the size of the difference depends on how performance is defined and the separate performance dimensions weighted. Equal weight to affective performance dimensions and common task dimensions should result in the greatest chance for compensatory tradeoffs to occur. Table 7 summarizes the algorithm options related to the Army's selection and classification problem.

Definition of Job Sets

Integral to the classification decision of job set contract models is the definition of the job sets. Several options are currently available as described briefly in Table 8. These are all based on the similarity of the MOS on the criterion side of the predictor/performance puzzle. Three other basis for clustering should be considered.

First, MOS could be clustered based on similarity of predictor requirements. Within this alternative, there are some options. For example, MOS could be grouped by their similarity regarding current ASVAB aptitude area composite requirements. Alternatively, MOS could be clustered by ASVAB subtest validities. Finally, MOS could be clustered by validity profiles that include the full array of predictors included in Project A (Peterson, Hough, Dunnette, Rosse, Houston, & Toquam, 1990) or the predictor array considered in the Synthetic Validity Project (Owens-Kurtz & Peterson, 1989). Project A and Synthetic Validity data are available for exploring this option. The Army has a history of MOS clustering based on aptitude requirements and other attributes. An early example is Maier and Fuchs' (1972) examination of MOS clusters using subtests from the Army Classification Battery. More recently, Konieczny, Brown, Hutton, and Stewart (1990) reported on the development of the Enlisted Personnel Allocation System (EPAS) for classifying recruits. EPAS clusters MOS on four descriptors: (a) ASVAB area composites and cutoff scores, (b) difficulty of filling the MOS, (c) quality distribution goals of the MOS, and (d) gender constraints (Paul, 1984). Driven by commonalities in aptitude area requirements (which are determined by MOS proponent agencies which, in turn, are aligned with CMF), the 38 resulting clusters are similar to the Army Career Management Fields (CMF), but they are not congruent.

Table 7

Selection and Classification Algorithms

Classifi- cation	<p>Batch - For assigning MOS within job sets:</p> <p>Predictor Cutoffs - One or more cut scores set one or more predictors per MOS. Assign according to fill needs to maximize average distance above cutoffs.</p> <p>Predicted Performance - Multiple predictors combined by regression solutions for each MOS. Assign according to MOS fill needs to maximize overall predicted performance.</p> <p>Hybrid - Assign according to MOS fill needs to maximize ASVAB aptitude area scores.</p>
	<p>Sequential - For establishing eligibility for MOS or job sets:</p> <p>Predictor Cutoffs - One or more cut scores set on one or more predictors per MOS. Offer assignments to meet fill requirements.</p> <p>Predicted Performance - Multiple predictors combined by regression solutions. Simulate maximizing overall predicted performance by offering assignments to individuals based on where they fall in comparison to a hypothetical (expected) distribution of recruits.</p> <p>Hybrid - Simulate maximizing ASVAB composite scores by offering assignments to individuals based on where they fall in comparison to a hypothetical (expected) distribution of recruits.</p>
Selection	<p>Sequential only for screening out applicants</p> <p>Predictor Cutoffs - Lowest common denominator and multiple hurdles procedures</p> <p>Predicted Performance Cutoffs - Single equation to combine predictors</p>

Table 8

Available Job Set Options

Career Management Fields (Department of Army, 1984)	Functionally similar MOS that share common career paths. (31 clusters)
Enlisted DOD Occupation Codes (Department of Defense, 1984)	DOD military jobs clustered by similarity of job duties. (52 clusters)
Integrated Defense Occupational Stratification Codes (Department of Defense, 1984)	DOD military and civilian jobs clustered by similarity of job duties. (47 Army related clusters)
Project A Job Clusters (Hoffman, 1987)	Army MOS clustered by similarity of task requirements. (23 clusters)
Synthetic Validity Job Clusters (Peterson, et al, 1991)	Army MOS clustered by similarity of task requirements (4 clusters from representative MOS)

Johnson, Zeidner, and Leaman (1992) clustered MOS explicitly to maximize similarity of prediction within the MOS clusters. However, this research is paradoxical. On the surface, creating MOS clusters with similar aptitude requirements would facilitate the use of job set contracts in recruiting. However, the clusters contain jobs that are very divergent in terms of task content. For example, in one of their solutions, the following MOS appeared in common clusters:

- cannon crewmember clustered with medics,
- military police clustered with helicopter repairers, and
- clerks clustered with cooks.

While the clusters may be similar in aptitude requirements, they do not appear to be very marketable. That is, recruiters might have a very hard time selling these as job sets for which a recruit, after enlisting, could be assigned as either a cannon crewmember or a medic, an MP or helicopter mechanic, or a cook or clerk.

This then leads to the second option for clustering MOS which is to group MOS in terms of their similarity of occupational interests. Project A developed a vocational interest instrument (AVOICE, Army Vocational Interest Career Examination) tailored for Army MOS (Peterson, et al., 1990). Offering recruits job sets that are based on vocational interest could be an alternative that matches MOS contracts in terms of satisfying recruits preferences for Army assignments. Project A data are also available for exploring this option.

Prior to this point, we have implicitly assumed that job sets would consist of fixed clusters of MOS. An alternative that should also be considered is that of dynamic job sets tailored to match the aptitude requirements of MOS with the aptitude capabilities and interest preferences of recruits.¹³ In other words, instead of relating MOS to each other, it may be feasible to relate MOS to persons such that clusters of MOS are created around the individual. Further refinement could be made during contract negotiations if recruits were allowed to indicate MOS in their cluster that for one reason or another, they would not accept. Processing could not be conducted "within job set" as previously described because there would be no identifiable sets of jobs. Conceptually, however, one could imagine a large person-by-MOS matrix that, for a given time period, includes all MOS and all recruits contracted under such a dynamic arrangement. Values in the matrix (e.g. predicted performance or predicted value) could be overridden by indices (e.g., zeros) that signal which MOS do not belong to recruits' job sets. Recruits would not be assigned to these MOS.

Effects of Model Components on Identified Outcomes

Table 9 summarizes our subjective evaluation of how the various selection and classification components meet the proposed system criteria. There are three kinds of effects. First, components may directly produce the desired system outcome. Second, components may produce the outcome only under certain contingent conditions. Third, components may facilitate the success of other procedures that more directly address the outcome. In essence, the

¹³This option was encouraged by Peter Legree, ARI, in a review of an initial draft of this report.

Table 9

Evaluation of Alternative Selection and Classification Components

System Criteria	Pre-MEPS				MEPS			Post Accession	
	Initial ability screening			ABLE Screen Cut	Contract				SPM
	Counseling Screen	ASVAB with AFQT Cut	AFQT Cut with later subtest admin.		ABLE	SPM	MOS Contract	Job Set Contract & Post Access Classif.	
Recruiting									
Reduce cost of evaluating/ testing recruits	X	X	X	X					
Reduce recruiting transportation	X	X	X	X					
Satisfy recruit preferences							X	X	
Reduce recruiting costs							X	X	
Transition									
Reduce DEP loss							?	? (See text)	
Training									
Reduce training transportation								X	
Optimize training capacity								X	
Reduce time between basic and AIT								X	
Increase probability of completing training				X	X	X	X		X
Reduce training costs				X	X	X	X	X	X
Affective orientation									
Reduce first term attrition				X	X				
Reduce number of discipline problems				X	X				
Increase "will do" motivation				X	X				
Performance									
Meet a minimum level of aptitude							X	X	
Match a distribution of aptitudes							X	X	
Increase average distance above MOS cutoff								X	
Increase predicted performance				X	X	X			X
Fill jobs with most qualified people available				X	X	X		X	X
Fill all jobs with people who meet minimum cutoffs							X	X	
Meet fill priorities								X	
Increase utility				X	X	X		X	X

components may have main effects or be involved in interactions. Table 9 does not sort out these differences but simply indicates whether or not each component is expected to facilitate achieving each of the criteria.

Initial Ability Screening Procedures During Pre-MEPS Phase

There are three initial ability screening options presented in Table 9. All three assume a multiple hurdles algorithm with AFQT as an early hurdle. The objective is to reduce the cost of assessing recruits.

EST or CAST pre-screen

The EST or CAST pre-screen functions through the recruiters' counseling to weed out low aptitude individuals from further consideration thereby reducing costs for evaluating recruits, including reduction of travel costs. Because the EST and CAST are highly correlated with AFQT, they could be used with an automatic cut. There is a potential for recruiters to corrupt such a system, but these cases should be few and they should be caught by later ASVAB testing.

Early AFQT cut from full ASVAB administration

The results from full ASVAB testing at MET sites are used to determine whether prospects are sent on to the MEPS. This also weeds out low aptitude individuals from further consideration reducing costs for further evaluations, including reduction of associated travel costs. Because administration of the ASVAB, if not available from high school, requires a trip to a MET site, costs may not be reduced as much as by using CAST with either recruiter counseling or a CAST cutoff. On the other hand, depending on the strength of the correlation between CAST and AFQT, the cutoff on the AFQT may be set higher resulting in more persons cut. Also, depending on the frequency with which CAST is subverted, AFQT cuts may result in more lower ability recruits being eliminated from further testing.

Early AFQT cut with remaining subtests administered later

Again an AFQT cut is applied to reduce the number of recruits in subsequent testing. This alternative proposes dividing the ASVAB into AFQT and non-AFQT subtests for separate administrations. The viability of this options depends on the trade-offs among (a) the numbers of recruits that take the ASVAB in high schools versus recruits requiring the recruiters to schedule its administration, (b) cost per recruit differentials for shorter administration time (i.e., for AFQT subtests only) versus requirements for two separate test periods, and (c) numbers of recruits who are eliminated from further testing by the AFQT cut. The added costs of two separate ASVAB administration periods, even if fewer people are in the second session, would seem likely to override the gains of shortening the sessions. Further, though AFQT screening at MET sites using current standards followed by MEPS testing for only those who made the cut might have some savings, a pre-screen or early AFQT cut/full ASVAB administration seems more defensible.

Comparison of the initial screening methods

By eliminating low aptitude recruits, each of these three initial screening options can:

- Reduce the cost of evaluating/testing recruits, and
- Reduce recruiting transportation costs.

Given the expected similarity of outcomes across the options, it is appropriate to consider only a single model for initial ability screening. A hybrid model is suggested that would use AFQT as a cut for recruits who took the ASVAB in high school and use CAST to cut low aptitude recruits from those who did not take the ASVAB in high school. This hybrid is essentially the status quo with more emphasis on eliminating low aptitude recruits. With the Recruiting Command's targeting plans, the number of low aptitude recruits sent to MEPS is already held down. In essence, this is a recommendation to not evaluate any alternatives regarding initial ability screening. This recommendation simplifies evaluation of the models by reducing the total number of options from 45 to 15. On the other hand, it remains appropriate to evaluate how alternative AFQT cut scores affect the tradeoff between meeting MOS needs and reduced recruiting costs.

ABLE

Use of the ABLE can provide some incremental validity over the ASVAB because it predicts affectively-oriented performance factors. Thus, use of the ABLE may positively influence the following criteria:

- Increase probability of completing training
- Reduce training costs (by decreasing training attrition and recycles)
- Reduce first term attrition
- Reduce discipline problems
- Increase "will do" dimensions of performance
- Increase (overall) predicted performance, where performance is defined by Project A's five dimensions
- Fill jobs with most qualified available, where "qualified" is defined by the selection/classification instruments that predict performance
- Increase utility
- Reduce recruiting costs

Either MEPS or pre-MEPS administration of the ABLE can influence the above objectives. In addition, pre-MEPS application of an ABLE cut can potentially reduce the costs associated with the MEPS evaluation and associated travel. On the other hand, feasibility with issues and costs for pre-MEPS ABLE administration may outweigh gains from reducing the number of applicants sent to the MEPS. Finally, pre-MEPS ABLE scores may be combined in a compensatory equation with AFQT. This could allow a tradeoff such that some recruits with lower levels of AFQT, but high ABLE scores are accepted, thereby reducing the costs associated with recruiting high AFQT candidates and decreasing attrition rates and, thus, costs associated with otherwise lower quality recruits.¹⁴ Given that pre-MEPS administration has potentially the most to gain, only models with pre-MEPS ABLE and no ABLE should be compared. By eliminating models with MEPS administration of ABLE, the number of alternative models to be evaluated is reduced to 10.

¹⁴This outcome was suggested by Paul Hogan.

Spatial/Psychomotor Test Battery

Predicated on an incremental increase in the prediction of task performance, the spatial/psychomotor (SPM) battery is hypothesized to positively affect the following criteria:

- Increase the probability of completing training
- Decrease training costs
- Increase predicted performance
- Fill jobs with most qualified
- Increase utility
- Reduce recruiting costs

All or part of the SPM may be administered during the MEPS or post-accession (e.g., at the reception station). For all models, whether they call for MOS contracts or for assignment to job sets, the SPM option needs to be evaluated as an addition to MEPS testing. Administered prior to contract negotiation, SPM could be included in a compensatory regression equation with other ASVAB scores. Similar to the ABLE, this may allow a tradeoff such that some low ASVAB recruits with high SPM scores are accepted into positions currently only available to high ASVAB recruits, thus lowering recruiting costs. The feasibility of reception station testing has already been demonstrated by Project A, but this procedure would work only with job set contract models and then SPM could only be applied within job set decisions. Depending on how job sets are defined, SPM differences are more likely to differentiate performance between job sets than within job sets. On the other hand, there may be a role for post-accession use of SPM if aptitude requirements differ or if job sets are constructed in some manner unrelated to SPM. For the time being, the two models that include post-accession use of SPM will be retained until definitions are clarified for the job sets.

Initial Contract

MOS versus Job set contracts

Contracts for specific MOS assignments are presumed to increase the attractiveness of enlistment and therefore:

- Satisfy individual preferences/interests
- Reduce the costs of recruitment.

MOS contracts can also:

- Meet a minimum level of aptitude
- Match a distribution of aptitudes

Job set contracts, on the other hand, offer the Army flexibility in making assignments and matching job needs. This flexibility can be used by appropriate decision algorithms to:

- Reduce transportation costs (to training)
- Optimize training capacity
- Reduce time between basic and AIT
- Reduce training costs
- Meet a minimum level of aptitude

- Match a distribution of aptitudes
- Fill jobs with most qualified people available
- Increase average distance above MOS aptitude cutoff for those assigned
- Fill all jobs with people who meet minimum qualifications
- Meet fill priorities
- Increase utility

If job sets are created by similarity of vocational interests or are tailored to meet recruits' idiosyncratic characteristics, then job sets may also meet the criteria of:

- Satisfying individual preferences/interests
- Reducing the costs of recruitment.

Type of contracts may also affect DEP loss, but, because the influence is not direct the overall outcome is uncertain. Contracts for specific MOS may generate stronger attraction and less desire to drop during the delay period. On the other hand, job set contracts may reduce the delay time and give less opportunity for events to occur that lead to dropping.

Selection and Classification Algorithms

Two selection algorithms and six classification algorithms are identified above. Table 10 matches these algorithms to the remaining selection and classification models. Each model requires an algorithm for making selection decisions and a sequential classification algorithm for making initial contracts. Job set models require batch algorithms for making the post-accession MOS assignments. These batch algorithms may or may not include new predictors. Depending on the character of the MOS in the job sets, predictors used for initial contracts (e.g. aptitude area composites and SPM) may be useful for post-accession assignments.

Table 11 summarizes expected effects of the algorithms on the system criteria presented above. Evaluations are based on the potential for the procedures to directly or indirectly influence the various criteria using any potential modifications that have been discussed. For example, using cutoff procedures for selection can match a distribution if multiple cuts are used. Likewise, MPP optimization procedures can meet a minimum requirement if cutoff constraints are added, or they can create a "quality" distribution if MOS are subdivided and the parts differentially weighted in value. In addition, the evaluation for sequential classification assumes the use of an accurate hypothetical distribution. Thus, at this point, evaluations are biased to avoid any Type II errors of failing to recognize potential effects. As a result, evaluations within three major categories of selection, sequential classification, and batch classification tend to be similar, with each option showing an array of desired effects. However, the table does not indicate the relative strengths of any of these effects. Modeling of the various options should clarify the magnitude of the differences.

Table 10

Candidate Selection and Classification Models and Possible Algorithms

	Pre-MEPS			MEPS		Post Accession	Selection	Classification						
				Contract			Sequential		Batch			Sequential		
	AFQT or CAST Screen	ABLE Screen/Cut	SPM Classification	MOS Contract	Job Set Contract & Post Access Classif.	SPM Classification	Cutoff	Predicted Performance	Cutoff	Hybrid	Predicted Performance	Cutoff	Hybrid	Predicted Performance
1. 1	X			X			X	X				X	X	X
4. 2	X				X		X	X	X	X	X	X	X	X
5. 2	X				X	X	X	X	X	X	X	X	X	X
10. 3	X		X	X			X	X				X	X	X
13. 4	X		X		X		X	X	X	X	X	X	X	X
16. 1+ABLE	X	X		X		X	X	X				X	X	X
22. 2+ABLE	X	X			X		X	X	X	X	X	X	X	X
23. 2+ABLE	X	X			X		X	X	X	X	X	X	X	X
34. 3+ABLE	X	X	X	X			X	X				X	X	X
40. 4+ABLE	X	X	X		X		X	X	X	X	X	X	X	X

Table 11

Potential Effects of Alternative Selection and Classification Procedures

System Criteria	Selection		Classification					
	Sequential		Sequential			Batch		
	Cutoff	Predicted Performance	Cutoff	Hybrid	Predicted Performance	Cutoff	Hybrid	Predicted Performance
Recruiting								
Reduce cost of evaluating/testing recruits	X							
Reduce recruiting transportation	X							
Satisfy recruit preferences	X							
Reduce recruiting costs								
Transition								
Reduce DEP loss								
Training								
Reduce training transportation								
Optimize training capacity								
Reduce time between basic and AIT								
Increase probability of completing training								
Reduce training costs								
Affective orientation								
Reduce first term attrition								
Reduce number of discipline problems								
Increase "will do" motivation								
Performance								
Meet a minimum level of aptitude	X	X	X	X	X	X	X	X
Match a distribution of aptitudes	X		X			X		
Increase average distance above MOS cutoff of those assigned			X	X		X	X	
Increase predicted performance	X	X	X	X	X	X	X	X
Fill jobs with most qualified available		X		X	X		X	X
Fill all jobs with people who meet minimum qualifications	X	X	X	X	X	X	X	X
Meet fill priorities			X	X	X	X	X	X
Increase utility			X	X	X	X	X	X

Critique

Four variables are introduced by the alternative selection and classification procedures (use of a formal AFQT cut, use of SPM, use of ABLE, and use of job set contracts) with modeling proposed as the method for comparing their effects. In three of these cases, formal modeling may not be the most appropriate research tool. Eliminating evaluation of a formal AFQT cut procedure was already suggested because it is essentially equivalent to the Recruiting Command's current system of mission goals. As for the use of the SPM and ABLE, Project A data amply demonstrate their validities. Modeling their inclusion in selection or assignment using a data base that will probably be heavily weighted by Project A information will only serve to "rediscover" that finding. There is no need for modeling to determine that these two measures are useful.¹⁵

The impact of the use of the job set contract is less certain and deserves further attention. However, whether modeling is the appropriate analytic tool should be questioned. The primary argument for MOS contracts is that they make the Army more attractive and therefore more easily marketable than would be the case with uncertain job set contracts. Modeling *per se* will not answer the basic question of the attractiveness of the job set options. Modeling can only project the ultimate impact of the difference *if the options differ*. Surveying recruits is a more direct approach for the attractiveness question. A lack of a substantial difference between the two models would argue against further consideration. If they are different, then such a survey supplies data for modeling to determine how that difference plays out.

Beyond the basic models, there are a number of interesting and important questions concerning selection and classification procedures. These are the aforementioned issues of the definition of the job sets, and the relative advantages of the alternative selection and classification algorithms. These issues are not easily resolved and this is where modeling the alternatives can be beneficial. These are not issues that can be avoided. Even if it were important to do so, it is not possible to simulate the effects of ABLE, SPM, AFQT cuts, or the use of job sets without defining job sets and specifying selection and classification algorithms. Given our current knowledge, the effects of alternative job sets and the effects of alternative selection and classification algorithms are the most uncertain and deserve the greatest attention.

¹⁵ It should be noted that concerns continue to be raised regarding the potential for response distortion in an operational setting, particularly if such a self-report instrument is used for selection in contrast to classification. Such concerns persist despite the inclusion of validity scales on the ABLE to detect response distortion, other faking countermeasures, and study results indicating that faking is not an egregious threat to predictive validity.

REFERENCES

- Arabian, J.M., & Schwartz, A.C. (1990). Job sets for efficiency in recruiting and training (JSERT). Paper presented at the 32nd Annual Conference of the Military Testing Association, Orange Beach, AL.
- Bloxom, B. (1992, March). Armed Services Vocational Aptitude Battery and its use in selection and classification. A briefing presented to the ASVAB Review Workshop sponsored by the Defense Manpower Data Center, Washington, DC.
- Camara, W.J., & Laurence, J.H. (1987). Military classification of high aptitude recruits (FR-PRD-87-21). Alexandria, VA: Human Resources Research Organization.
- Campbell, J.P. (1989). Improving the selection, classification, and utilization of Army enlisted personnel: Annual Report, 1987 Fiscal Year (ARI Technical Report 862). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A219 046)
- Campbell, J.P., McHenry, J.J., & Wise, L.L. (1990). Modeling job performance in a population of jobs. Personnel Psychology, 43 (2), 313-333.
- Department of Defense. (1990). Population representation in the Military Services, Fiscal Year 1989. Washington, DC: Office of the Assistant Secretary of Defense (Force Management and Personnel).
- Eitelberg, M.J. (1988). Manpower for military occupations. Washington, DC: Office of the Assistant Secretary of Defense (Force Management and Personnel).
- Eitelberg, M.J., Laurence, J.H., Waters, B.K., with Perelman, L.S. (1984). Screening for service: Aptitude and education criteria for military entry. Washington, DC: Office of the Assistant Secretary of Defense (Manpower, Installations, and Logistics).
- Harris, D.A., McCloy, R.A., Dempsey, J.R., Roth, C., Sackett, P.R., Hedges, L.V., Smith, D.A., & Hogan, P.F. (1991, February). Determining the relationship between recruit characteristics and job performance: A methodology and a model (FR-PRD-90-17). Alexandria, VA: Human Resources Research Organization.
- Hoffman, R.G. (1989, April). Description and prediction of Grafenwoehr M1 tank table VIII performance (IR-PRD-89-07). Alexandria, VA: Human Resources Research Organization.
- Hogan, P.F., & Mullin, T.M. (1992). Developing and evaluating concepts of operation for administering the Armed Services Vocational Aptitude Battery (ASVAB). Fairfax, VA: Decisions Science Consortium, Inc.
- Hunter, J.E. (1980). Test validation for 12,000 jobs: An application of job classification and validity generalization analysis to the General Aptitude Test Battery (GATB). Washington, DC: U.S. Employment Service, Department of Labor.

- Johnson, C.D., & Zeidner, J. (1990). Classification utility: Measuring and improving benefits in matching personnel to jobs (IDA Paper P-2240). Alexandria, VA: Institute for Defense Analysis.
- Johnson, C. D., Zeidner, J., & Leaman, J. A. (1992). Improving classification efficiency by restructuring army job families (ARI Technical Report 947). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A250 139).
- Konieczny, F. B., Brown, G. N., Hutton, J., & Stewart, J. E. (1990). Enlisted personnel allocation system: Final report (ARI Technical Report 902). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A229 095)
- Kroeker, L.P. (1989). Personnel classification/assignment models. In M.F. Wiskoff & G.M. Rampton (Eds.). Military personnel measurement: Testing, assignment, evaluation. New York: Praeger.
- Maier, M. H. & Fuchs, E. F. (1972). Development and evaluation of a new ACB and aptitude area system (Technical Note 239). Arlington, VA: U.S. Army Behavioral Science Research Laboratory. (AD 751-761)
- Maier, M. H. & Grafton, F.C. (1981). Aptitude composites for ASVAB 8, 9, and 10. (Research Report 1308). Arlington, VA: U.S. Army Behavioral Science Research Laboratory. (AD A109 471)
- McHenry, J.J., Hough, L.M., Toquam, J.L., Hanson, M.A., & Ashworth, S. (1990). Project A validity results: The relationship between predictor and criterion domains. Personnel Psychology, 43 (2), 335-354.
- Paul, G. E. (1984). Enlisted personnel allocation system: MOS clustering (GRC-PSO-84-1317-45). McLean, VA: General Research Corporation.
- Peterson, N.G., Hough, L.M., Dunnette, M.D., Rosse, R.L. Houston, J.S., & Toquam, J. L. (1990). Project A: Specification of the predictor domain and development of new selection/classification tests. Personnel Psychology, 43 (2), 247-276.
- Peterson, N.G., Owens-Kurtz, C.K., & Rosse, R.L. (1991). Formation of job performance prediction equations and evaluation of their validity (chapter 4). In Wise, L.L., Peterson, N.G., Hoffman, R.G., Campbell, J.P., & Arabian, J.M., Army synthetic validity project: Report of Phase III results, Volume I (ARI Technical Report 922). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A235 635).
- Owens-Kurtz, C.K. & Peterson, N.G. (1989). Development of an Attribute Taxonomy and Its Application in the Formation of Synthetic Validity Composites. In Wise, L.L., Arabian, J.M., Chia, W.J., & Szenas, P.L. Army synthetic validity project: Report of Phase I results (ARI Technical Report 845). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A219 926).

- Pina, M., Emerson, M.S., & Leighton, D.L. (1988). Processing and classification of enlistees PACE) system pay off algorithm development. Randolph Air Force Base, TX: Air Force Human Resources Laboratory.
- Russell, T.L., Knapp, D.J., & Campbell, J.P. (1992). Building a joint-service classification research roadmap: Defining research objectives. Alexandria, VA: Human Resources Research Organization.
- Sadacca, R., Campbell, J.P., DiFazio, A.S., Schultz, S.R., & White, L.A. (1990). Scaling performance utility to enhance selection/classification decisions. Personnel Psychology, 43 (2), 367-378.
- Shields, J. L., & Hanser, L.M. (1990). Designing, planning, and selling Project A. Personnel Psychology, 43 (2), 241-245.
- Wainer, H. (1976). Estimating coefficients in linear models: It don't make no nevermind. Psychological Bulletin, 83 (2), 213-217.
- Wigdor, A.K., & Green, B.F., Jr. (1991). Measuring job competency. In Wigdor, A.K., & Green, B.F., Jr. (Eds.), Performance assessment for the workplace. Washington, DC: National Academy Press.
- Wise, L.L., McHenry, J.J., & Campbell, J.P. (1990). Identifying optimal predictor composites and testing for generalizability across jobs and performance factors. Personnel Psychology, 43 (2), 355-366.